THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

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ANNUAL MEETING OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

The annual meeting, or convention, of the Hawaiian Sugar Planters' Association, was held in Honolulu, November 20 to 23 inclusive, and was well attended by the managers of plantations, and members of the Association.

This November number of the Monthly is devoted exclusively to the reports presented at the meeting, and to the most important discussions upon the subjects presented by the reports.

The committees appointed early in the year to compile reports for the meeting were as follows: Experiment Station, W. M. Giffard, Chairman, E. D. Tenney and G. M. Rolph; Labor, E. F. Bishop, Chairman, Wm. Pfotenhauer and Royal D. Mead; Cultivation, A. Adams, Chairman, F. Weber, C. B. Wells, A. Lidgate, Wm. Pullar and T. S. Kay; Fertilization, C. F. Eckart, Chairman, A. Moore, H. A. Baldwin, C. Wolters, James Gibb and James Webster; Irrigation, W. W. Goodale, Chairman, B. D. Baldwin, L. Barkhausen and John Hind; Hauling and Transportation of Cane, G. F. Renton, Chairman, H. P. Faye, J. T. Moir, D. C. Lindsay, K. S. Gjerdrum and Geo. Chalmers; Manufacture, J. N. S. Williams, Chairman, E. Madden, Wm. Stodart, E. K. Bull, J. A. Scott and J. Watt; Machinery, C. Hedemann, Chairman, C. C. Kennedy, James Scott and H. H. Renton; Utilization of By-Products, G. H. Fairchild, Chairman, Fred. Meyers, J. N. S. Williams and Geo. Ross; Forestry, L. A. Thurston, Chairman, J. M. Lydgate, H. A. Baldwin, D. Forbes, E. Olding and G. Gibb; Labor Saving Devices, J. A. Low, Chairman, W. G. Ogg, P. McLane and Albert Horner.

Reports were presented by the Committees on Experiment Station, Labor, Fertilization, Manufacture, Machinery, Forestry and Labor Saving Devices, and appear herein in full.

Almost a full day was devoted to the Experiment Station. The advantages and benefits derived therefrom are becoming more manifest to the plantation interests, and the co-operation of managers is being freely extended. To those who live on the other Islands, and are thus unable to keep in close touch with the work at the Station, it was perhaps somewhat of a surprise to note the great development which has occurred during the past year, the extent, and future scope, of the investigations which are and will be pursued, and the facilities for aiding and carrying on the work. Since the last annual meeting the Divisions of Pathology and Physiology and Entomology (the latter division at that time not having been entirely organized) have been fully and completely established and equipped, and together with the Divisions of Chemistry and Agriculture are doing scientific work of the greatest value to the sugar industry of Hawaii.

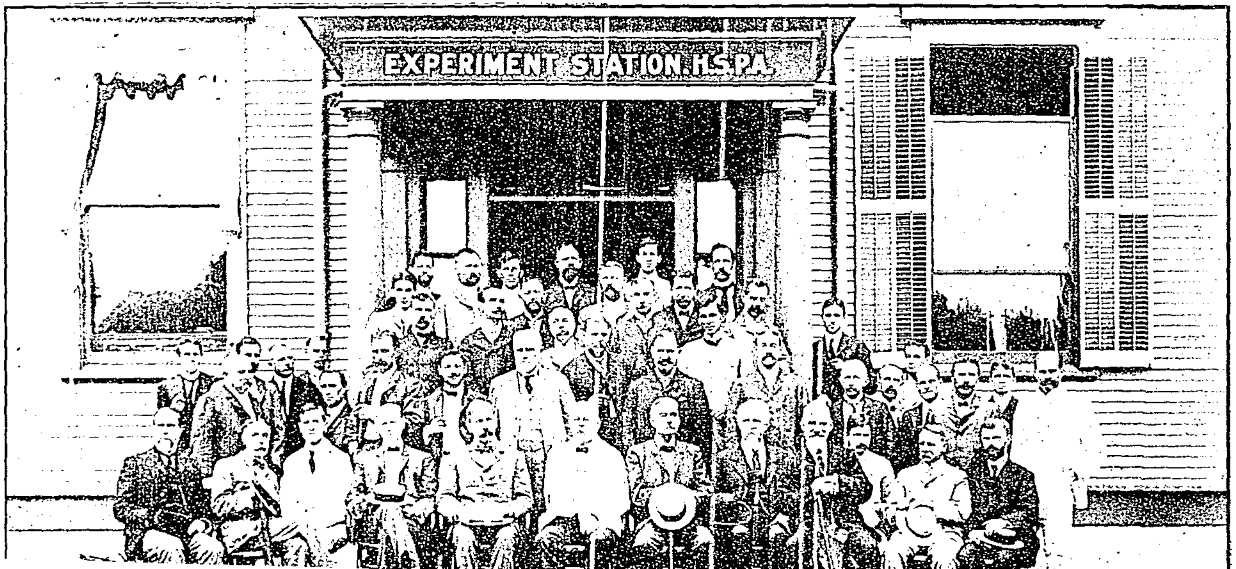
Much interest was manifested by the members of the Association in the very complete, and in some instances, novel and ingenious, apparatus used in the Pathological Department. The insectories where parasites and enemies of our various insect pests are being bred for distribution, and particularly the minute parasite which destroys the leaf-hopper eggs, received much attention.

Many favorable comments were made upon the appearance of some of the canes propagated from seed, and it was freely predicted that while many of such seedlings would probably prove worthless, eventually canes would be developed that would produce a heavy yield, and high sucrose content, and insure the planters against a repetition of their experience with Lahaina cane.

We take this opportunity of making due acknowledgement of a copy of the year book of the Experiment Station, compiled and edited by Mr. W. M. Giffard, a member of the Board of Trustees of the Hawaiian Sugar Planters' Association, and who, as chairman of the Experiment Station Committee, is entitled to much credit for the rapid development of the Station. The year book includes the report of the Committee, reports from each division of the Station, and the bulletins issued during the year. It is profusely illustrated, and contains, among other cuts and engravings, a number of hand colored plates, executed by the artists, illustrating the bulletins dealing with the inspection and disinfection of cane cuttings and the gumming of sugar cane. This book, we believe, sets the standard for publications of like nature.

Other pleasant and instructive events of the meeting were illustrated lectures delivered by Doctor N. A. Cobb and Mr. L. Lewton-Brain, on diseases of cane, and by Mr. Alexander Craw, on beneficial insects, all of which appear herein in proper order.

The annual dinner held in the evening of the last day of the meeting, afforded the members of the Association and their guests, an opportunity of meeting in a social way, and was a fitting close to the proceedings of the most successful and interesting annual meeting thus far held.


EXPERIMENT STATION H.S.P.A.

THE HAWAIIAN PLANTERS' ASSOCIATION. --*Williams Photo.*

Proceedings of the Twenty Fifth Annual Meeting of the Hawaiian Sugar Planters' Association

Held in Honolulu. November 20th to 24th. 1905

ELECTIONS FOR THE ENSUING YEAR:

H. P. BALDWIN, President.
GEO. H. ROBERTSON, Vice-President.
W. O. SMITH, Secretary and Treasurer.
E. FAXON BISHOP, Auditor.

The above are the officers for the ensuing year of the Hawaiian Sugar Planters' Association, elected at the noon recess of that body in annual meeting, November 20th, by the Board of Trustees, which had been re-elected at the opening session in the forenoon. Mr. Isenberg's place on the Board had been filled by Mr. Pfotenhauer, so that the Board is now constituted as follows: H. P. Baldwin, G. R. Robertson, W. O. Smith, F. M. Swanzy, E. D. Tenney, F. A. Schaefer, W. G. Irwin, S. M. Damon, W. Pfotenhauer.

There was a large attendance at the opening of the twenty-fifth annual convention of the sugar planters. With F. M. Swanzy, last year's president, in the chair, there were present H. P. Baldwin, E. K. Bull, W. A. Bowen, G. Chalmers, J. P. Cooke, W. H. C. Campbell, Geo. F. Davies, J. Dyer, C. F. Eckart, Geo. H. Fairchild, J. Fassoth, David Forbes, H. P. Faye, Alex. Garvie, A. Gartenberg, Geo. Gibb, Jas. Gibb, A. Gross, W. M. Giffard, W. W. Goodale, W. W. Hall, C. F. Hart, J. Hind, T. S. Kay, C. C. Kennedy, P. McLane, C. McLennan, R. D. Mead (Assistant Secretary), F. Meyer, J. T. Moir, W. Pfotenhauer, G. F. Renton, F. A. Schaefer, J. A. Scott, W. O. Smith, J. G. Spencer, F. M. Swanzy, F. Weber, James Webster.

PRESIDENT'S ADDRESS.

"We are met together again after a year which has been quite a successful one from a financial point of view, and the season has dealt kindly with our plantations on the whole. True, in some districts there has been less rain than was needed, and in others, more than was desired, but taking it all round the season has been a favorable one, and has resulted in the production of over 426,000 tons of sugar, which, though not the largest crop ever produced on these Islands, is close to it. The ravages of the Leaf Hopper are responsible for a smaller yield than we had hoped for during the planting of the crop just harvested, and cane diseases of one kind or another have left their mark on the outturn, which would, but for these drawbacks, have exceeded that of previous years. It is, however, satisfactory to note the wonderful effect, which is being wrought on the Leaf Hopper by the parasites discovered and collected in Australia and Fiji by those accomplished entomologists, Messrs. Koebele and Perkins, and there would appear to be good reason to hope that, though we may never be altogether rid of the Leaf Hopper, its depredations will at all events be so materially lessened that they will no longer make serious inroads on our crops. Too much praise cannot be given to Messrs. Koebele and Perkins for the arduous and admirable work done by them in securing these parasites, nor must we fail to give the credit which is due to those members of the staff of the Entomological division, Messrs. Kirkaldy, Terry and Sweezy, for their successful efforts in the breeding of these minute insects after they came into their hands.

You were told last year of the intention to establish a Pathological Division of our Experiment Station, necessitated by the development of disease in our cane. I have the pleasure to inform you that this division has now been fully organized and equipped, and we have been fortunate in securing the services of Messrs. Cobb and Lewton-Brain, both well-known specialists in their particular line of research, to investigate these diseases and assist in their suppression.

Besides the erection of laboratories and offices required for the Pathological Division the Association has acquired a plot of ground on which diseases can be studied in their active state.

The Agricultural Division, under the able direction of Mr. Eckart, has been doing great things in several directions, notably in the raising of new seedling varieties of cane, many of which will doubtless prove of great value in the future.

These and other matters will be fully dealt with in the reports of the Experiment Station Committee and the divisional directors, and it is therefore unnecessary for me to make more than this passing reference to the changes and improvements of the past year at our valuable and necessary Experiment Station. I must, however, not neglect an expression of appreciation of the valuable aid which has been rendered to this Association by the chairman of the Experiment Station Committee, Mr. W. M. Giffard. This gentleman has always taken a deep interest in the station, especially in recent years, and the thanks of this Association are due to him for the great amount of time and attention he has so unselfishly devoted to its successful establishment and development.

At the opening of our meeting of a year ago I had the pleasure to announce to you the telegraphic quotation of 4.65 cents for Centrifugals in New York. I wish I could convey like glad tidings to you on this occasion, but the change which has come over the sugar market in the course of twelve months is so great that I do not care to even mention to-day's price. We must of course expect such "ups and downs," but with a world's crop estimated at 11,500,000 tons it looks more like "downs" than "ups" for quite a time yet. It is with the purpose of helping our industry to face with equanimity these painful drops in value that this Association is directing its efforts to killing off destructive insects, hindering the spread of disease, creating new varieties of cane, seeking for improvements in methods of cultivation and manufacture, and generally assisting in the production of good yields of sound, rich cane and the economical transformation of its juice into bagged sugar.

This Association has also in its care many other matters of the first importance, some of which though not directly connected with the raising of cane or manufacture of sugar, are none the less essential not only to the sugar industry but to the general welfare of these Islands. It goes then without saying that the unfailing co-operation of all the members of this Association with its Board of Trustees is essential to the success of the Association's efforts, and in soliciting a continuance of that co-operation so heartily given in the past I do so with the firm conviction that no possible aid or support will at any time be withheld when it is sought.

By the untimely and, in all its circumstances, particularly sad death of Mr. H. Alexander Isenberg this Association has sustained a grievous loss. In the deliberations of your Board of Trustees, and in the general meetings of the Association of which he was but recently the president, expressions of his opinion were listened to with invariable attention, and his great interest in the Association's work was intelligent and continuous. The Board of Trustees has, I am sure, voiced the sentiments of the entire Hawaiian Planters' Association in its resolutions of sympathy with the family and relatives of Mr. Isenberg and the house of H. Hackfeld & Co., Ltd., but it is none the less appropriate that on this occasion and in this company of association members further reference should be made to an event which has deprived this community of one who was so generally popular and so highly regarded, and whose absence from among us we sincerely deplore.

SECRETARY'S REPORT.

The last annual meeting of the Association was held November 16th-18th inclusive, in the rooms of the Association in Honolulu.

At that meeting the following named trustees were elected: F. A. Schaefer, F. M. Swanzy, E. D. Tenney, W. G. Irwin, H. A.

Isenberg, H. P. Baldwin, G. H. Robertson, S. M. Damon and W. O. Smith.

The trustees organized and elected the following officers: F. M. Swanzy, president; H. P. Baldwin, vice-president; W. O. Smith, secretary and treasurer, and G. H. Robertson, auditor.

The committees appointed by the President in January, 1905, were as follows:

Labor: E. F. Bishop (chairman), Wm. Pfotenhauer, Royal D. Mead.

Cultivation: A. Adams (chairman), F. Weber, C. B. Wells, A. Lidgate, Wm. Pullar, T. S. Kay.

Fertilization: C. F. Eckart (chairman), A. Moore, H. A. Baldwin, C. Wolters, James Gibb, James Webster.

Irrigation: W. W. Goodale (chairman), B. D. Baldwin, L. Barkhausen, John Hind.

Hauling and Transportation of Cane: G. F. Renton (chairman), H. P. Faye, J. T. Moir, D. C. Lindsay, K. S. Gjerdrum, George Chalmers.

Manufacture: J. N. S. Williams (chairman), E. Madden, Wm. Stodart, E. K. Bull, J. A. Scott, J. Watt.

Machinery: C. Hedemann (chairman), C. C. Kennedy, Jas. Scott, H. H. Renton.

Forestry: L. A. Thurston (chairman), J. M. Lidgate, H. A. Baldwin, D. Forbes. E. E. Olding, G. Gibb.

Experiment Station: W. M. Giffard (chairman), E. D. Tenney, G. M. Rolph.

Labor Saving Devices: J. A. Low (chairman), W. G. Ogg, P. McLane, Albert Horner.

Utilization of By-Products: G. H. Fairchild (chairman), Fred Meyer, J. N. S. Williams, Geo. Ross.

A few changes have occurred in the personnel of the committees, Mr. Bishop having been succeeded by Mr. J. P. Cooke as chairman of the Labor Committee; Mr. G. F. Renton resigning as chairman of the Committee on the Handling and Transportation of Cane; and Mr. Hedemann resigning as chairman of the Committee on Machinery, Mr. C. C. Kennedy having been appointed in his place.

The proceedings of the last annual meeting were printed and bound, and although there was some delay in this work, copies thereof were finally distributed to the managers and will be of value for reference in the future. It is planned to follow the same course this year.

At the last annual meeting a committee consisting of Messrs. J. N. S. Williams, G. F. Renton, G. H. Fairchild and J. Watt, was appointed to confer with the Hawaiian Sugar Chemists' Association for the purpose of preparing forms for reports of mill work and to recommend some uniform method of stating results. This committee met with the committee from the Chemists' Association, and as a result of their conference, forms for weekly mill reports were adopted, and a number of the mills during last season returned weekly reports on the forms prepared by the committee. The results obtained from these reports have been very useful in preparing the report of the committee on manufacture this year, and such reports by being exchanged with the various mills making returns are of value to the mill managers and chemists in pointing out where economies may be practiced and greater efficiency be obtained.

The Board of Trustees has held fifty-two meetings during the year, and there have been two meetings of Trustees and delegates.

Many matters of interest and importance have been before the Board of Trustees. Labor matters have been and are among the most important subjects for consideration by the Association.

In the month of May, 1905, the Islands were visited by Dr. C. P. Neill, United States Commissioner of Labor; Victor H. Clarke, his assistant, and F. B. Sargent, Commissioner General of Immigration; Hon. W. P. Hepburn, member of Congress from Iowa, paid the Islands an extended visit, and the celebrated Taft party was also here for one day. The Trustees had the pleasure of meeting and discussing labor matters with Messrs. Neill, Clarke and Sargent, and with Colonel Hepburn.

All these gentlemen without exception urged upon us the great desirability and advisability of endeavoring to obtain white labor for the plantations; they suggested that an agent of the recently organized Board of Immigration be sent to New York and also to European countries to investigate, and if possible, to obtain laborers from there.

The Board of Immigration also had meetings with Mr. Sargent, and, following his suggestion, addressed a letter to the Planters' Association requesting detailed information as to the number of white laborers that could be employed upon plantations, and the inducements that the plantations were prepared to offer to such laborers.

The matter was taken up by a special committee of the Board of Trustees and a circular letter sent to each plantation company, setting forth the condition of labor affairs and requesting replies to questions therein submitted.

A number of the plantations made favorable replies and the Board of Immigration was informed that a total of 350 families of white agricultural laborers could find immediate employment.

This matter is being vigorously pressed by the Board of Immigration, its superintendent now being in the East investigating the matter of obtaining the laborers.

Submitted herewith are the returns of the crop of 1904-1905, which show a total tonnage of 426,284.

The Experiment Station has submitted a statement showing the yields of the various Islands for the crops of 1904 and 1905, also yields of the irrigated and unirrigated plantations, which are as follows:

YIELDS BY ISLANDS.

Oahu.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs
1904	15,832.00	102,019.78	12,888
1905	18,782.84	123,094.76	13,107

Kauai.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	14,959.15	64,603.47	8,637
1905	16,541.82	76,313.42	9,227

Maui.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	13,948.80	77,926.00	11,173
1905	15,116.46	100,433.77	13,288

Hawaii.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	47,057.67	122,855.54	5,281
1905	45,002.39	127,523.73	5,667

YIELDS OF SUGAR FOR THE TERITORY OF HAWAII CROPS OF 1904 AND 1905.

Total Yields.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	91,797.66	367,405.07	8,005
1905	95,443.51	427,365.68	8,955

Irrigated Plantations.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	42,809.99	239,987.91	11,212
1905	48,668.12	295,797.99	12,156

Unirrigated Plantations.

Year.	Acres.	Tons of Sugar.	Yield Per Acre Lbs.
1904	48,987.67	127,417.16	5,202
1905	46,775.39	131,567.69	5,625

The total tonnage shown in this statement is a little at variance with the figures printed in the crop return, but this variance is accounted for by the fact that the plantations, in reporting their tonnage to the Experiment Station, return the

STATEMENT OF HAWAIIAN SUGAR CROP, 1904-1905

From October 1, 1904, to September 30, 1905.

ISLANDS	TONS	TOTAL TONS
HAWAII.		
Hawaii Mill Co	1,438	
Waiakea Mill Co	7,661	
Hilo Sugar Co	9,971	
Onomea Sugar Co	11,049	
Pepeekeo Sugar Co	6,167	
Honomu Sugar Co	5,909	
Hakalau Plantation Co	10,862	
Laupahoehoe Sugar Co	5,866	
Ookala Sugar Plantation Co	3,712	
Kukaiau Plantation Co	1,415	
Kukaiau Mill Co	1,416	
Hamakua Mill Co	5,925	
Paauhau Sugar Plantation Co	8,006	
Honokaa Sugar Co	6,895	
Pacific Sugar Mill	4,342	
Niulii Mill and Plantation	1,645	
Halawa Plantation	925	
Kohala Sugar Co	3,350	
Union Mill Co	2,166	
Hawi Mill	3,687	
Hutchinson Sugar Plantation Co	7,107	
Hawaiian Agricultural Co	1,620	
Puakea Plantation	262	
Olaa Sugar Co	11,361	
Puna Sugar Co	3,147	
Puako Plantation	500	
		126,405
MAUI.		
Kipahulu Sugar Co	1,324	
Kaeleku Plantation Co., Ltd	2,720	
Maui Agricultural Co	17,820	
Hawaiian Commercial and Sugar Co.	39,411	
Wailuku Sugar Co	7,516	
Olowalu Co	1,652	
Pioneer Mill Co., Ltd	25,581	
Kihei Plantation Co., Ltd	4,410	
		100,434
OAHU.		
Waimanalo Sugar Co	3,428	
Laie Plantation	857	
Kahuku Plantation Co	7,431	
Waialua Agricultural Co	19,722	
Waianae Co	5,128	
Ewa Plantation Co	32,380	
Apokaa Sugar Co	454	
Oahu Sugar Co	33,589	
Honolulu Plantation Co.	20,106	
		123,095
KAUAI.		
Kilauea Sugar Plantation Co	2,290	
Makee Sugar Co	8,335	
Lihue Plantation Co	14,185	
Grove Farm Plantation	1,679	
Koloa Sugar Co	6,172	
McBryde Sugar Co	13,136	
Hawaiian Sugar Co	19,062	
Gay & Robinson	2,151	
Waimea Sugar Mill Co	1,305	
Kekaha Sugar Co	7,318	
Estate V. Knudsen	680	
		76,314
TOTAL		*426,248

AGENTS	TONS	TOTAL TONS
W. G. Irwin & Co., Ltd.		
Honolulu Plantation Co	20,106	
Paauhau Sugar Plantation Co	8,006	
Hutchinson Sugar Plantation Co.	7,107	
Hakalau Plantation Co	10,862	
Hilo Sugar Co	9,971	
Kilauea Sugar Plantation Co	2,290	
Waimanalo Sugar Co	3,428	
Olowalu Co	1,652	
		63,422
H. Hackfeld & Co., Ltd.		
Lihue Plantation Co	14,185	
Grove Farm Plantation	1,679	
Koloa Sugar Co	6,172	
Kekaha Sugar Co.	7,318	
Pioneer Mill Co., Ltd	25,581	
Kipahulu Sugar Co	1,324	
Kukaiau Plantation Co	1,416	
Oahu Sugar Co	33,589	
Hawaii Mill Co., Ltd	1,438	
		92,702
Theo. H. Davies & Co., Ltd.		
Waiakea Sugar Co	7,661	
Laupahoehoe Sugar Co	5,866	
Kukaiau Mill Co	1,416	
Hamakua Mill Co	5,925	
Niulii Mill and Plantation	1,645	
Union Mill Co	2,166	
McBryde Sugar Co	13,136	
Puakea Plantation	262	
		38,077
C. Brewer & Co., Ltd.		
Hawaiian Agricultural Co	1,620	
Wailuku Sugar Co	7,516	
Honomu Sugar Co	5,909	
Onomea Sugar Co	11,049	
Ookala Sugar Plantation Co	3,712	
Pepeekeo Sugar Co	6,167	
		35,973
Castle & Cooke, Ltd.		
Waialua Agricultural Co	19,722	
Ewa Plantation Co	32,380	
Apokaa Sugar Co	454	
Kohala Sugar Co	3,350	
Waimea Sugar Mill Co	1,305	
		57,211
Alexander & Baldwin, Ltd.		
Hawaiian Sugar Co	19,062	
Maui Agricultural Co	17,820	
Hawaiian Commercial & Sugar Co.	39,411	
Kihei Plantation Co., Ltd	4,410	
Kahuku Plantation Co	7,431	
Laie Plantation	857	
		88,991
F. A. Schaefer & Co.		
Honokaa Sugar Co	6,895	
Pacific Sugar Mill	4,342	
		11,237
M. S. Grinbaum & Co., Ltd.		
Kaeleku Plantation Co., Ltd.		
		2,720
Henry Waterhouse Trust Co., Ltd.		
Gay & Robinson	2,151	
Halawa Plantation	925	
		3,076
Bishop & Co.		
Olaa Sugar Co		
		11,361
Puna Sugar Co.		
Puna Sugar Co		
		3,147
Makee Sugar Co.		
Makee Sugar Co		
		8,335
J. M. Dowsett.		
Waianae Co		
		5,128
Hind, Rolph & Co.		
Hawi Mill	3,687	
Puako Plantation	500	
		4,187
H. M. von Holt.		
Estate V. Knudsen		681
TOTAL		*426,248

* 2,000 pounds to the ton.

Hawaiian Sugar Planters' Association,

HONOLULU, November 1, 1905.

By its Secretary,

WILLIAM O. SMITH.

10 Hawaiian Sugar Crops, 1896-1905

From September 30, 1896, to October 1, 1905.

HAWAII	1896 *TONS	1897 TONS	1898 TONS	1899 TONS	1900 TONS	1901 TONS	1902 TONS	1903 TONS	1904 TONS	1905 TONS
Waiakea Mill Co.	6,410	8,239	7,763	9,191	9,226	10,800	8,700	9,954	6,151	7,661
Hilo Portuguese Sugar Mill Co.	105	661	260	932	967					
Hawaii Mill Co.						843	985	1,503	1,728	1,438
Hilo Sugar Co.	7,216	6,744	8,390	6,880	7,841	10,214	9,255	13,108	7,701	9,971
Onomea Sugar Co.	10,013	10,432	8,904	8,404	7,131	8,722	11,880	13,472	10,940	11,049
Pepeekeo Sugar Co.	6,502	7,474	6,914	7,350	6,207	7,173	6,627	6 000	4,907	6,167
Honomu Sugar Co.	3,844	5,181	4,932	4,968	5,328	4,401	6,235	6,384	5,489	5,909
Hakalau Plantation Co.	7,675	9,461	9,218	8,980	11,931	10,932	11,700	11,293	8,396	10,862
Laupahoehoe Sugar Co.	2,430	6,032	3,971	5,337	4,119	5,504	7,909	4,856	4,336	5,866
Ookala Sugar Plantation Co.	3,261	2,583	3,555	3,564	3,302	4,968	1,157	3,942	2,214	3,712
Kukaiau Plantation Co.	890	1,817	1,170	1,748	1,525	2,000	1,118	1,746	1,275	1,415
Kukaiau Mill Co.	890	1,818	1,170	1,732	1,530	2,000	1,118	1,746	1,274	1,416
Hamakua Mill Co.	7,330	9,050	4,133	6,081	6,078	7,808	2,105	6,950	4,691	5,925
Paauhau Sugar Plantation Co.	10,957	10,135	3,509	7,529	7,629	9,635	1,322	9.136	7,533	8,006
Honokaa Sugar Co.	6,774	10,018	6,198	9,111	8,117	9,903	3,089	8,587	7,402	6,895
Pacific Sugar Mill	5,885	6,700	3,327	4,650	4,774	4,948	2,517	6,059	3,388	4,342
Niulii Mill and Plantation	1,468	2,317	1,349	2,226	1,805	1,516	1,146	1,903	1,189	1,645
Halawa Plantation	1,198	1,406	800	1,049	1,571	1,357	575	1,860	1,016	925
Kohala Sugar Co.	3,778	4,903	1,508	4,119	3,345	3,160	1,096	5,409	2,663	3,350
Puehuehu Plantation	1,256	1,007								
Union Mill Co.	1,230	994	1,068	1,668	2,265	2,003	463	3,380	1,776	2,166
Hawi Mill.	2,775	1,823	877	1,222	2,277	2,727	1,373	5,563	3,631	3,687
Beecroft Plantation	1,043	1,485	426	609	632	325				
Kona Sugar Co.					285	1,500	1,391	1,850	897	
Hutchinson Sugar Plantation Co.	9,179	7,544	7,104	7,732	8,338	9,928	8,021	7,527	5,741	7,107
Hawaiian Agricultural Co.	6,660	8,553	4,795	11,318	9,001	10,956	11,998	18,888	10,954	1,620
L. C. Chong—Pahala	530	359	265	839						
Puakea Plantation						145	307	366	201	262
Olaa Sugar Co.						1,150	16,748	15,030	13,788	11,361
Puna Sugar Co.							2,460	3,603	3,146	3,147
Puako Plantation								550	438	500
	109,299	126,736	91,606	117,239	115,224	134,618	121,295	170,665	122,865	126,405
MAUI										
Kipahulu Sugar Co.	1,787	2,047	2,250	1,931	1,890	1,992	1,427	1,622	1,415	1,324
Hamoa Plantation	1,378	852	1,411	2,026	2,114	1,450	1,748			
Hana Plantation Co.	2,771	2,350	2,141	3,175	3,406	2,774	2,700	4,922	2,662	
Kaeleku Plantation Co., Ltd.										2,720
Haiku Sugar Co.	4,986	5,400	4,648	4,865	5,512	5,488	4,234	6,397		
Maui Agricultural Co.									13,521	17,820
Paia Plantation	5,606	6,376	5,801	6,268	6,795	7,216	4,146	7,856		
Hawaiian Commercial and Sugar Co.	11,933	12,537	15 072	16,621	17,858	22,345	19,477	33,230	29,829	39,411
Wailuku Sugar Co.	5,655	6,461	6,725	7,412	7,976	7,902	5,934	7,490	6,451	7,516
Olowalu Co.	1,163	1,112	1,425	1,502	1,480	1,240	1,055	843	1,125	1,652
Pioneer Mill Co., Ltd.	3,818	3,912	5,560	10,589	10,316	6,568	9,960	16,530	17,036	25,581
Kihei Plantation Co. Ltd.						1,374	5,562	5,629	5,461	4,410
Maui Sugar Co.							483	257	485	
	39,097	41,047	45,033	54,389	57,347	58,349	56,726	84,776	77,985	100,434
OAHU										
Waimanalo Sugar Co.	3,370	2,230	3,004	2,352	2,932	3,045	2,985	3,218	2,963	3,428
Heeia Agricultural Co., Ltd.	1,915	1,798	2,167	2,191	2,309	1,507	631			
Laie Plantation	101	78	300	494	179	1,693	430	724	597	857
Kahuku Plantation Co.	3,369	3,976	4,356	7,008	5,647	7,072	5,623	8,212	6,360	7,431
Waialua—Halstead Bros.	1,019	1,886	2,015							
Waialua Agricultural Co					1,516	17,699	17,001	19,800	18,682	19,722
Waianae Co.	3,884	3,804	4,055	3,506	4,019	4,020	5,000	5,348	5,500	5,128
Ewa Plantation Co.	12,124	15,157	18,284	22,334	21,573	33,036	38,775	33,162	29,797	32,380
Apokaa Sugar Co.							901	610	874	454
Oahu Sugar Co.				7,935	15,450	21,454	26,724	29,256	20,870	33,589
Honolulu Plantation Co.						10,008	9,800	20,736	16,376	20,106
	25,782	28,929	34,181	45,820	53,625	99,534	107,870	121.066	102,019	123,095
KAUAI										
Kilauea Sugar Plantation Co.	5,507	4,651	4,563	5,420	5,254	5,364	3,762	3,012	1,850	2,290
Makee Sugar Co.	7,439	9,175	8,510	9,350	8,575	9,954	11,232	8 215	7,840	8,335
Hanamaulu Mill & A. S. Wilcox	2,386	2,550	3,194	3,962						
Lihue Plantation Co.	8,883	9,642	10,914	13,333	15,289	18,356	13,674	11,375	14,611	14,185
Grove Farm Plantation	1,632	1,513	1,355	1,751	1,962	2,183	2,915	1,896	1,679	1,679
Koloa Sugar Co.	3,852	3,825	4,327	5,268	5,004	5,492	5,001	4,825	6,172	6,172
A. H. Smith & Co.	675	176	469							
Eleele Plantation	1,232	1,400	1,489							
McBryde Sugar Co.				1,491	1,790	2,208	9,113	11,922	10,535	13,136
Hawaiian Sugar Co.	11,407	11,167	13,200	14,350	13,480	13,419	11,480	10,324	11,493	19,062
Gay & Robinson	1,508	1,510	1,600	1,821	2,001	1,554	2,265	1,645	1,665	2,151
Waimea Sugar Mill Co.	1,183	1,050	1,026	1,021	976	919	565	540	627	1,305
Meier & Kruse	1,245	1,505	1,518							
Kekaha Sugar Co	2,602	3,483	3,480	6,942	8,287	7,412	8,978	7,064	7,447	7,318
H. P. Faye & Co.	1,357	1,824	1,961							
Estate V. Knudsen	742	943	988	650	730	676	735	666	687	680
TOTAL	51,650	54,414	58,594	65,359	63,348	67,537	69,720	61,484	64,606	76,314

	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905
HAWAII	109,299	126,736	91,606	117,239	115,224	134,618	121,295	170,665	122,865	126,405
MAUI	29,097	41,047	45,033	54,389	57,347	58,349	56,726	84,776	77,985	100,434
OAHU	35,782	28,929	34,181	45,820	53,625	99,534	107,870	121,066	102,019	123,095
KAUAI	51,650	54,414	58 594	65,359	63,348	67,537	69,720	61,484	64,606	76,314
TOTAL *	225,828	251,126	229,414	282,807	289,544	360,038	355,611	437,991	367,475	426,248

*2,000 Pounds to the Ton.

Hawaiian Sugar Planters' Association,

HONOLULU, November 1, 1905.

By its Secretary,

WILLIAM O. SMITH.

total amount produced for the crop, while in reporting to the Secretary of the Association, they return the amount produced for the year ending September 30, 1905.

The total out-turn was considerably in excess of what was originally expected, due very largely to the exceedingly favorable season preceding and during the harvesting of the crop.

It was very fortunate indeed that the harvesting was enabled to proceed rapidly as the planters were thereby enabled to ship sugar early in the season, and obtained the very good prices then prevailing.

The crop of 1905-1906 is estimated at about 385,000 tons.

The plan adopted at the meeting two years ago of having the reports printed before the meeting, has been carried out so far as possible this year; but some of the committees have failed to hand in reports. It would seem that matters relating to fertilization, cultivation and irrigation are handled throughout the year by the Experiment Station and there is very little left for committees to report upon.

The Experiment Station has been enlarged very considerably during the past year, and the scope of the work increased materially; the report from the committee this year will be of great interest.

Great credit is due to the staff of the Station for the work which they have done, and also to the Experiment Station committee, and especially to its chairman, for the manner in which the work has been systemized and carried on.

In March of 1905, Mr. H. A. Isenberg, on account of his contemplated absence, resigned as a member of the Board of Trustees, and Mr. W. Pfotenhauer was elected in his place.

Recently the community and the Board of Trustees have been shocked by the untimely death of Mr. Isenberg, and expressions of regret and sympathy have been tendered to his family, and to the house of H. Hackfeld & Co.

In the month of September, Mr. W. M. Haywood, who has been the representative of the Association in Washington for a number of years, and who has performed capable and efficient work, resigned his position because of ill health, he having suffered another attack of throat trouble, and the Trustees were very fortunate indeed in obtaining the services of Mr. F. M. Hatch so well known to all of us. Mr. Hatch takes up his duties in Washington on the first of December.

Respectfully submitted,

W. O. SMITH,

Secretary H. S. P. A.

Mr. H. P. Baldwin—I would like to say that I find there is no uniformity of method in handing in or making returns to the Planters' Association of the area in cane on the Islands. The old-fashioned way was to hand in the area of the whole field.

At Makaweli we always calculated the area of our cane fields in that way. If in a field of 100 acres there were rock piles and waste land that amounted to two or three acres or more, that would be estimated in a rough way and deducted, but as I say, only large deductions of that sort were handed in.

When I took charge of the Hawaiian Commercial & Sugar Co., at least when we came into control there, the manager, Mr. Lowrie, told us that he had been following the Ewa method of deducting roads and all main ditches through the land, that is, what we call straight and level ditches and any other ditches that amounted to anything. I suggested that it would be a good plan to leave out the spaces between the rows, that they amounted to considerable, but he said "No, that would be going a little bit too far." We are now at Makaweli making no deductions unless they are for large spaces in the field. I do not know what they do on Hawaii, but I think the method is becoming more and more to leave out the spaces that are not really in cane, for instance, roads and all main ditches, that is straight and level ditches. Those who irrigate will understand what I mean by straight and level ditches—the little irrigation ditches through the plantations are not left out. I do not know whether this is the time to discuss it or not, but as the land that is taken up by roads and these ditches amounts to between five and ten per cent. of the whole field there is no uniformity, as one party may hand in his field at 90 acres and another at 100. It makes quite a difference and it either makes the plantation's yield look mighty fine or very poor. I think the time will come when we will leave out a great deal more than we do today. Statistics are being carefully got together and published every year and there should be a uniformity in regard to the method of leaving out land in making an estimate.

Mr. G. F. Renton—Mr. Baldwin was mistaken about the manner of survey at Ewa. The level ditches through the field are included in the area of the field. Large roads 20 or 25 feet wide and roads lying through the fields up from the railroad tracks of course are not considered as part of the field.

Mr. Baldwin—The former manager left them out I know. He told me so.

The following resolution was unanimously adopted:

WHEREAS Almighty God in His divine wisdom has removed by death our esteemed colleague and friend, Mr. H. Alexander Isenberg,

BE IT RESOLVED, that we hereby express our tribute to the memory of our departed friend, and sorrow at the loss which has come to us and to this community, and we desire to tender to the bereaved wife and mother of the deceased and to the house of Messrs. H. Hackfeld & Company our deepest sympathy.

Reports of Committees.

REPORT ON FERTILIZATION.

By C. F. Eckart.

Honolulu, T. H., November 9th, 1905.

To the Trustees and Members of the Hawaiian Sugar Planters' Association.

Gentlemen:—The committee appointed by the president to prepare the Report on Fertilization for this Annual Meeting of the Hawaiian Sugar Planters' Association comprised: C. F. Eckart, A. Moore, H. A. Baldwin, C. Wolters, James Gibb and James Webster.

This subject has been dealt with so fully by committees in the past who have considered in detail not only the great diversity of practices in the various island districts, but who have also presented statistics covering the nature, amounts, and values of fertilizing materials used in the Hawaiian Islands, that little remains to be said on this point at the present time in view of the fact that no material changes in methods have been effected during the past year. At the last annual meeting of the Association, the belief was expressed by several plantation managers that a considerable amount of money was being expended annually for fertilizers by the plantations which was not returned through increased yields of sugar, and that in their opinion the quantities of fertilizing material could in many instances be decreased with considerable saving. A number of theories were advanced as to the reasons for the poor response shown by the cane crop to the costly application of chemical fertilizers and a considerable measure of responsibility was placed upon our insect and fungus enemies in the field. When we consider that over $2,000,000 is spent annually in the attempt to not only maintain, but in many instances to increase, the productiveness of the cane lands of the Territory, the importance of giving these statements our careful consideration is fully brought home to us.

While there is no question that, in the long run, the profits of a plantation may be very materially increased through the judicious use of fertilizing material, there is also little doubt but what during certain seasons no benefits are derived and the money expended in this manner constitutes a loss. The reasons for this may be briefly summarized as follows:

The health and vigor of the sugar cane is, as in the case of all plants, influenced by conditions of soil and climate. Under climate must be considered the temperature, humidity of the air, winds, the amount and distribution of the rainfall, and the relative number of sunshiny and cloudy days. Under conditions of soil come exposure, depth, drainage, and the mechanical and chemical composition of soil and subsoil. For each type of soil there must exist certain conditions, not only in the soil but also as regards climate as well, for the maximum production of cane on land of the given character. Also for each kind of climate there must be types of soil, subjected to the influences of the same, which permit a variation in the yields following cropping. For instance, a thin, sandy soil deficient in organic matter, will give larger yields of cane in districts or during seasons where the rainfall is regularly distributed than where the same amount of rain falls at longer intervals. Again, in very wet districts, soils which are readily drained yield larger amounts of sugar per acre than where the soils are retentive of moisture to a much larger degree. Each condition of soil and climate bears a certain relationship to all of the other conditions and where in the case of any soil type there prevails during the course of a crop period an adjustment of these concomitant influences which most nearly meets the requirements of the sugar cane for maximum development, maximum yields necessarily follow. With the modification of one or more of the factors in question, as the result of seasonal or soil variations, a readjustment of the separate influences naturally becomes necessary for the maintenance of greatest growth. For example, a certain decrease in the humidity of the air increases the evaporation of moisture from the cane leaves and from the soil and unless a corresponding decrease in the air currents or increase in rainfall properly distributed is coincident with this change, the growth of the plant suffers a certain check. This modification of the amount of water held by a unit volume of air, not only influences the amount of water evaporated from the soil and leaf surface, but indirectly reacts upon the soil and produces changes which are of considerable moment to the plant. The quantity of water in the soil is lessened and many conditions dependent upon the supply of soil moisture are affected. The micro-organisms which are actively engaged in the breaking down of the complex organic substances into simpler compounds for the use of the sugar cane find conditions less favorable for the active fulfillment of their functions and in consequence, the amounts of available nitrogent are in a measure diminished. This diminution in the supplies of naturally-occurring nitrates means also that less of the bases, such as lime, magnesia, etc., which enter into their composition are dissolved in the soil water. Other changes produced by a modification of the humidity conditions could be cited to show the intimate relationship existing among the many soil and climatic influences which determine crop yields, but enough has doubtless been said to fully illustrate this point. Now since some of the many factors bearing upon crop production nearly always vary in no inconsiderable degree during different seasons while other influences are not altered to counterbalance the changes taking place, the result is naturally manifested in the fluctuation of the yields of cane.

It is apparent that through the use of chemical fertilizers only a few of the conditions affecting the growth of the cane crop can to a certain extent be modified. By placing in the land plant food materials, the natural supplies of which are insufficient to permit the thrifty growth of the plant. gratifying results in the way of increased yields are obtained, providing the many conditions of soil, other than that represented by the chemical composition, and the state of the weather do not exert a restraining influence. Excessively wet weather, drought, low temperatures, high winds, soil acidity, poor drainage, bad tilth, and a score of other causes including the results of insect and fungus attacks, may limit the growth of cane to such an extent that the supplies of plant food naturally existing in the soil are sufficient to meet all requirements. Increasing the quantities of nitrogen. potash, phosphoric acid, lime, etc., in such cases would not result in any appreciable benefit to the crop to which they are applied, although with the amelioration of conditions, subsequent crops might derive some advantage from the previous fertilization. Because unfavorable influences prevailing during one crop period yield results which are negative with respect to the use of fertilizers during that period, the belief is not warranted that a saving can always be effected through the discontinuation of fertilizing practices. Nothing would constitute a greater backward step in the agriculture of the sugar cane than the practical application of such a theory. founded, as it would be, upon a faulty and unscientific hypothesis.

While considerable attention has been given to the subject of fertilization in these islands and experiments have been pursued from time to time to throw much needed light upon the action of fertilizing materials on the soils of the various plantations, much more remains to be done along such lines before somewhat definite knowledge can take the place of many speculative theories which are offered in explanation of numerous soil and fertilizer problems. The plantation manager of the Hawaiian Islands can profit but little from the experimental work carried on in other countries where not only the soil and climatic conditions are radically different from those he is accustomed to, but where likewise a considerable variation in the composition of canes grown, allows very different quantities and proportions of the plant food materials to be extracted from the soil. Dr. J. D. Kobus, of the East Java Experiment Station, has figured out that while the total mineral matter withdrawn from the soil per acre by 17 Hawaiian varieties of cane amounts to 5,750 pounds, in Java the average quantity used by 30 varieties was only 1,170 pounds. In a letter to the chairman of the committee, he stated:

"In every instance our losses are only about one-fourth or one-fifth of those sustained in your soils."

A number of analyses of canes made during the past year by the Experiment Station has shown conclusively that not only the same variety, taken from different elevations, differs widely in its general composition, but also that the same variety grown at different elevations on the same plantation makes very different draughts upon the principal soil elements. This is due to two causes:

1. Under different conditions of soil and climate, the mineral and nitrogenous ingredients of the stalk and leaves vary in their proportional amounts, and

2. The leaves differ considerably from the stalks in their composition, and insomuch as the proportion of leaves and stalks often show wide variations in different localities with the same variety of cane, the amounts of mineral matter taken from the soil must often show a material variation.

The subject of fertilization therefore becomes a very broad one and, as has been stated in various committee reports, must be solved in large measure by each plantation manager for his particular conditions. While the analysis of soils will in many cases prove of value as a guide in the matter of fertilization, there are many instances where the mechanical and chemical analysis of soils alone form an inadequate basis for forming a satisfactory opinion of the manurial needs of a field. In conjunction with such analyses, the climatic features of the field must be taken into account and the most suitable forms of the separate fertilizer ingredients determined after a consideration of these factors. A great deal of work has already been done with reference to soils in general and no inconsiderable amount of attention has been devoted to the soils of Hawaii in particular, but it is needless to say that further research is required to place our knowledge on a surer basis. It is true that soil chemistry as a science is in its infancy, but it is also true that in all progressive agricultural communities, the practical bearing of chemistry, physics, and bacteriology on the many soil problems presented to the agriculturist, has become manifest, and today a greater degree of reliance is placed upon the findings of the laboratory when supplemented with data from the field than was the case a decade ago. While, therefore, there still remains an almost inexhaustible field for continued investigation in this science as in the case of all other sciences, a number of fundamental principles have been derived from the sifted data of experiments which have proved of exceptional value in determining modern agricultural practices. Probably in no other country of the world does a greater variety of conditions prevail both as regards soil and climate than in the Hawaiian Islands and nowhere is there a greater need for co-operation between the plantation field and the laboratory in solving the question of economical fertilization. The sub-stations which are being established by the Hawaiian Sugar Planters' Association will prove of special value in this connection and the results obtained from the experiments which are being pursued will assist in the clearing up of a number of disputed questions. The manager, however, can with profit both to the individual interests of his particular company and to the sugar industry at large, go further into the solution of many fertilizer problems by properly conducted experiments under his own supervision and practical tests on fallowing, green manuring, times for fertilizing, economical limits as to amounts of fertilizer required and utilization of by-products from the mill and stables, with the assurance of gaining a store of more accurate information concerning this very important subject.

Respectfully submitted,

C. F. ECKART,

Chairman, Committee on Fertilization.

Honokaa, Hawaii, H. T., August 24th, 1905.

C. F. Eckart, Esq.,

Chairman, Committee on Fertilization,

Honolulu.

Dear Sir:—Your letter of the 12th inst. to hand, and in reply would say that I have little to add to your report on fertilization.

We are experimenting all the time in a general way with fertilizer. The only experiment from which we obtained actual results this crop, was a comparison with and without fertilizer in the seed bed. We usually apply about 400 pounds high grade fertilizer with the seed. In 1903 we planted about 30 acres without fertilizer with the seed, in the middle of a field of 253 acres. Though this section had an application of 500 pounds high grade along with the balance of the field during second hoeing, yet it showed a poorer stand of cane during its growth. We carefully cut and weighed five acres of each immediately adjoining, with the following results:

Cane from land fertilized with seed.....37.75 tons per acre.

Cane from land not fertilized with seed..31.30 tons per acre.

I believe it pays to fertilize all cane to a certain limit. The quality and quantity can best be determined by practical experience—though constantly appreciating the scientific guidance of the H. S. P. A. Experiment Station—as different soils will profitably respond to different fertilizers in various quantities.

I believe in applying fertilizer in small quantities, say in two or three applications, first with the seed, then with the first or second hoeing. When we have settled on the grade or quality or fertilizer for cane, we have still a splendid field for experiment in arriving at the proper quantity. It may be generally granted that applying 800 pounds fertilizer to an acre of cane will increase the yield of sugar 1,000 pounds. How much can we increase the application to obtain results in the same ratio? When does the quantity applied reach the point where it ceases to be profitable?

Yours respectfully,

(Signed) JAS. GIBB,

Manager Paauhau Sugar Plantation Co.

C. F. Eckart, Esq.,

Chairman of the Committee on Fertilization.

Dear Sir:—Your favor of the 12th of August, in reference to the report on Fertilizer, was received, since which I have considered very carefully the manner in which I can assist you in making up a report on the subject of Fertilization; and have decided that a few remarks on the application of fertilizers would open the subject for discussion at the meeting, and this would likely lead to some useful information being obtained.

For the past twenty years the practice of fertilizing the lands on which cane has been grown at the Hawaiian Islands has been generally followed. The plantation managers have had the benefit of experienced people at the Experiment Station in Honolulu, to test the soils of the different plantations, and to advise the ingredients needed in the fertilizer for each soil.

The material being known, and supplied as required, it is then the manager's duty to apply the same in such a manner that it may do the most good. The deciding as to manner of application, causes those in charge of the different plantations much thought, in which the character of soil, climatic conditions, and the manner in which the land is watered, all have to be taken into consideration; as an example, it is possible to apply fertilizers to lands that are free, of good depth, and watered by natural rainfall before the cane seed is planted, and not be in danger of losing the fertilizing elements in the fertilizer.

On other lands having a porous subsoil, and watered by artificial irrigation, the fertilizer must be applied after the cane has obtained sufficient root development to intercept the dissolved ingredients as they wash through the soil. In such cases it is advisable to divide the quantity of fertilizer to be used into as many applications as can be conveniently controlled. As the cane due to its growth takes from the ticable as used, unless they can be stored in the oil to be

soil elements needed, these should be applied as far as prac-
taken as required.

In fertilizing lands producing such heavy crops of cane, it is impossible to apply the material after the ground is covered, and this condition forces the applications to be made early in the growth of the crop, with the hope that as small a percentage of the soluble elements be lost as possible. Such being the case, it is of importance that every practicable measure be used to render the poorer soils as little liable to permit the leaching of the soluble elements of the fertilizer, at the same time to improve their absorbing qualities, and to obtain this condition it is advisable to plow into the soils leguminious crops whenever practicable; the outlay for this would be very quickly returned, through the better condition of the soil to retain moisture, with the soluble elements of the fertilizers and the improved crops that would result.

Yours respectfully,
(Signed) A. MOORE.

Mr. Baldwin—There is one question I would like to ask in regard to the matter and that is: how many of the planters fertilize with the seed, because I have been led to believe that this practice has been nearly given up. It certainly has been given up on the Island of Maui, as we think that the cane has not enough roots ready to take up the fertilizing materials put into the ground with the seed, and that where we irrigate certainly a part of the fertilizer is carried off in the water before the cane is in a condition to take it up. The methods of applying fertilizers, which we use on our irrigation plantations, differ, I believe, from those adopted where they do not irrigate. All this has to be borne in mind.

Mr. Moir—At Onomea we invariably apply with the seed about 500 pounds of tankage, containing from 11 to 12% of ammonia per acre. I have heard arguments for and against fertilizing with the seed. To decide the point, we left out towards the latter end of last planting season, in one field 6 acres, in another field 10 acres, and in a third one 20 acres. Today the fertilized part is from four to six weeks ahead of the cane, which was not fertilized. Therefore we believe it the right thing to fertilize along with the seed. Two years ago we tried nitrate on some plant cane, applying in March or April about 200 pounds to the acre of cane planted the previous year.

Mr. Baldwin—How old would that cane be?

Mr. Moir—About a year old. It had received all this tankage and the high grade fertilizers. The season before that, we simply gave it this dose to give it a little start and the results were as follows: In one case 200 pounds nitrate gave 56 tons cane to the acre, no nitrate only 37 tons, in the other case the 200 pounds nitrate gave 64 tons of cane to the acre; no nitrate only 42 tons.

Mr. Baldwin—We plow into the land barnyard material from our stables and ashes and that sort of thing. We plow it into the land because it is the most convenient way to put it in. That is sufficient reason to give for that. We also sluice in with water the barnyard material but not the ashes because they won't wash in the water as easily. I don't know what they do on Oahu, so I would like to hear from some of the Oahu managers of irrigation plantations. I know on Kauai they have ceased long ago to put in fertilizer with the seed; and further than that, as I say, we plow in the barnyard material and ashes and all material of that sort, what Mr. Moir may call tankage. Now I would like to say in this connection that since we have had the leaf hopper we do not consider it wise on Maui to get up too much of a growth of cane until well in the season. We plant in May, June, July, August, and September, and get it as much toughened as we can, as we found that the cane is not attacked by the leaf hopper as much as it would otherwise. We do not let it suffer actually, but we harden it up so that the leaf hoppers do not care to go into that field. The leaf hopper is very fond of good living and wants green, rank-growing cane. We first find that leaf hoppers will not attack the ratoons, and the only reason is that the ratoon is not a rank cane; so we have endeavored to harden our cane; we can do it with irrigation. We put on our first dose in November and December, even if the cane has been planted in June or July.

I would like to ask Mr. Eckart what experiments they have made at the Experiment Station in regard to this point. I did not notice it in his paper. These are important matters and I would like to know whether they have done anything with it at the Experiment Station or not.

Mr. Eckart—Experiments with the application of fertilizer with the seed are being conducted, the cane will be harvested in April next, and I think the results will be of considerable value.

Mr. Baldwin—When were those experiments commenced?

Mr. Eckart—Commenced last year and they are to be harvested next April. It has always seemed reasonable to suppose that if fertilizing materials are put on with the seed, especially when that material contains considerable nitrogen as nitrate or sulphate of ammonia, that before the roots of the cane are out sufficiently to take up the nitrates, which are formed from the fertilizer, it would be washed out of the land to a very large extent; it must be so where excessive irrigation is practiced, and I think it is impossible to put on water without there being a certain drainage from the land; I have also felt that there is a loss in the Hilo District, where conditions are as Mr. Moir describes and where very large amounts of tankage are used. I do not think 500 pounds an excessive amount, although a good deal of nitrate will no doubt form from that tankage before the cane is 7 or 8 weeks old. This subject requires further investigation, and the conclusion, that there is danger of the loss of considerable nitrate where we fertilize with the seed under the described conditions, seems logical.

Mr. J. A. Scott—When I took charge of the Hilo Sugar Co. fertilization was then just coming into use. In the former years there had been very little fertilization done, especially in the Hilo district, and we started in to fertilize with the seed. My experience has been, that labor cuts a very great figure in fertilizing with the seed. My experience has been that when fertilizing with the seed, the fertilizers caused the weeds to grow much more rapidly than the cane, and I looked on it in the light Mr. Eckart did, that there were no roots in the soil to which the fertilizers could furnish food. Where we fertilized with the seed—unless we were able to put on labor to hoe it immediately before the roots had sprung two or three inches out into the ground—it was necessary to hoe to get control of the weeds, as otherwise the weeds grew so rapidly that to remove them they would have to be removed by hand, which would disturb the seed in the ground and this, of course, is detrimental.

I know in one case there was an immense amount of replanting from that cause, so that I changed the policy and we have adopted the policy now of fertilizing with the first hoeing.

Formerly I gave two applications, but of late years I have divided up my fertilizations into three applications, putting on the first application at the first hoeing, the second application along in October, just before the cold weather sets in, and the third application before the warm weather sets in next April.

Mr. Baldwin—How many tons do you apply altogether?

Mr. Scott—At the present time I am giving twelve hundred pounds per acre. An application of four hundred pounds of high grade fertilizer each time.

In regard to the stable manure and ashes and mud press cakes I apply that on the land as much as possible before plowing and that is plowed in, and I can state in regard to fertilizers that there is nothing that can equal the ordinary manure. You can apply your high grade fertilizer as you wish, but there is nothing that can give the results as a good application of stable manure, say five or six tons to an acre. You see you don't lose it all in one crop, for you see it in your ratoons; as Mr. Eckart says, in applying fertilizers for the last three or four months, and with the rainfall that we have had in Hilo District, if we had applied the fertilizers with the seed before the roots were out to take up, why, it would have been down in Hilo Bay; and in some cases we have had to defer our second application for a week or even two, owing to the large rainfall, to prevent it from being washed out on our rolling lands before the cane could receive any benefit from it.

Mr. Smith—You speak of the greater cost of labor where you fertilize with the seed. Were there any special differences in the results of changing the policy of fertilizing later, in regard to the yield?

Mr. Scott—At that time we did not weigh our cane nor could I say anything in regard to the result, but I would say that it is not the same with us as on the irrigated plantations. We have a very small mill capacity and it does not pay us to shut down our mill and turn all the labor into the field for hoeing purposes. When we start grinding we have to keep it up continuously until the end of the crop. Mr. Moir has a large mill and he is so placed that he can probably shut down for a week or two if his fields should happen to get dirty. The whole operation on the plantation is going on continuously; we are planting, cutting and grinding, and labor cuts a big figure at that time. On the irrigated plantations, I understand, they largely do their planting in the later months of the year, when possibly their milling is done.

Mr. Moir—I quite agree with Mr. Scott on a good many of his points. One of the principal points is that we take care of our young cane, that is we shut down our mill if our fields of young cane require hoeing. If we did not do that, it would be a serious loss to us, because the weeds would get away with the most of our fertilizer. But I do not think that it would be good policy to stop fertilizing with the seed supply, because we are liable to have a heavy rain now and again. If we are going to stay off on that account, we might never plant any cane. We have to take our chances on that. Of course a heavy rain has got to go somewhere, but we make it a point to take care of the young cane in the way of hoeing, otherwise the fertilizer that we applied is thrown away.

Mr. James Gibb—I would like to corroborate what Mr. Moir said in regard to applying fertilizers with the seed. I have experimented with that more or less for the last 12 or 15 years. I did it on Mr. Scott's plantation when I was head luna there. I would leave out a few sections without applying fertilizers and I have also done the same thing since I have been at Paauhau. Every year I have left out 25 or 50 rows in two or three fields and I have no hesitation in saying that it is a benefit on the Island of Hawaii, from what I have seen and it would be hard to convince me, that it would be advisable to change from the plan of applying the fertilizers with the seed. When I was down here a year ago, I thought that it was all right, to have good advice and recommendations, but there were no actual facts brought out as to experiments, which we had all been making; and this year for the first time I had weighed the cane. In regard to the extra amount of weeds, which would spring up, there is no question in my mind, but what that is true, yet we have to see to it that the weeds are kept down, and if the weeds are kept down as they ought to be—although in the past we have had trouble in getting labor to do everything at one time—I think on the whole, that for the Island of Hawaii I would be strongly in favor of fertilizing with the seed.

There has not been a year in the last 12 years, that I have not made that experiment and I am thoroughly convinced, that it is a benefit.

Mr. Eckart—I think the difference in results obtained on different plantations using fertilizer with seeds and without, is due in a very large measure to the difference of conditions, the climate as well as the soil. The fertilizing material, which is going to be washed out of the soil between the time of planting and the rooting of the cane, is not going to be potash or phosphoric acid to any extent—those materials are fixed very quickly in the ground. The loss is going to be nitrogen and a small amount, which has passed into the form of nitrate during the period between the planting and the rooting of the cane. If we assume, that during rains, a certain amount of nitrogen has been washed from the soils on Mr. Moir's plantation, between the planting and the rooting of the cane, it might be quite a loss and still that loss might not be so harmful as it would be in other places where probably nitrogen was a more important fertilizer needed by the cane. For instance Mr. Moir, on your plantation probably potash or phosphoric acid would be needed more than nitrogen. I think by carrying on experiments, where we compare one area with another, that there is always apt to be some difference in the conditions of the soil, the exposure of the land, and the climatic influence. If you had a large experimental field, so that all of the conditions would be the same, there would be no question about the results. I do not mean to say anything against what has been stated, but I think that we could feel absolutely sure then that there was no disturbing factor to throw out the accuracy of the results. For instance, where you did not fertilize with your seed, the climatic conditions may have been more unfavorable and the soil may have been of less depth and there may have been less nitrogen in the soil in that locality than where you had fertilized with the seed. Field experiments are very difficult ones to carry out and feel safe over. At the Experiment Station, where we have these experiments continually under our eyes and can carry out the agricultural methods very carefully and subject the same influence on the different plats, we feel, that our results are often only approximate because there are conditions in the soil, which we can not measure nor can we see them. And I think on the plantation, unless great care is taken to have the plats running through the field so that all the plats get exactly the same treatment with regard to climate and also artificial conditions, which might be imposed, there would be a variation.

Mr. Moir—This experiment I was making was seed planted the same day. There might have been a difference in the soil.

Mr. Goodale—I would like to ask the Hilo Managers, who have fertilized with lime, what results they have had year after year. I think that has been done there for ten or twelve years and at the end of this time there must surely be some results, which would be appreciated.

Mr. Scott—I have used lime for many years. In fact I have made a complete circuit of the four thousand acres of the plantation applying seven barrels of caustic lime to every acre. This lime has been run through a disintegrater and spread on the field; and my experience has been that lime is of material importance on the land. I have noticed, that the fields that have been limed compared with those that did not receive an application, were very much better; that there was a vast difference in the appearance of the cane—the cane was green, strong and healthy compared with the fields that had not been limed, and I am just beginning to rotate again, liming the same fields, the fields that had received an application six or seven years ago; I could not apply fertilizer containing a large per cent. of potash on lands deficient of lime; I find that the potash has not the opportunity to become available on those lands.

Mr. Baldwin—I think that Mr. Eckart is quite correct and right in his conclusion in regard to fertilization with the seed or not fertilizing with the seed. It is a question largely of the nature of the soil. We all know that nitrogen is easily washed out. Only phosphoric acid and potash become quickly fixed in the soil.

There is another question, I would like to bring out in connection with Mr. Eckart's report and the work at the station, and that is the question of the influence of the fertilizer on the tasseling of the cane. It may be, that the present Experiment Station is not the place for making experiments of that kind. It is a subject that has interested me very much indeed, and I have made experiments in regard to the matter, more especially since the report that Mr. Maxwell made at one of our annual meetings, that fertilizing just before the tasseling of the cane would influence the tasseling so as to tide it over the tasseling time. Now I found a good many years ago, that the features, which influenced the tasseling of cane, are the proper amount of heat, water and air. Those are the elements, which influence and affect the tasseling of cane and nothing else. I have sometimes thought, that possibly the soil had something to do with it but I think not now. Of course soil leads to a large growth as against a small growth, but Dr. Maxwell makes a statement in one of his reports, that fertilizing will affect the tasseling of the cane so that it is tided over the tasseling time. Now my experience is, that fertilizing affects the tasseling in that it makes the growth so thick, that it does not get enough air and heat. This is an important point to us all, because it will regulate the time of planting and the fields we plant.

I am carrying on the experiments and hoped to have them finished in such a way, that I could have presented a paper here in connection with the cultivation of the cane, but have been unable to do it. It is an important matter to know when we should irrigate. We want to know how to regulate our cultivation so that the cane wont tassel. We all know what that means. So I think that experiments ought to be carried on at the Experiment Station in regard to this matter as it is a very important one.

I am willing to have a talk with Mr. Eckart sometime and give him my own results in regard to the matter, as I have not the time to go into this now.

Mr. Eckart—No experiments have been conducted along that line. Two years ago, the Experiment Station sent out a circular letter asking the managers about their experience in regard to the influence of nitrate on tasselling, and the consensus of opinion was that nitrogen prevented tasselling if applied very late; if applied after September (I remember a number of irrigating managers spoke of that) that it prevented tasselling to a very large degree; if applied before September, that it didn't have a material influence. I think it certainly would be very valuable work to be taken up, but I also think that it is experimental work which should be conducted out on the plantations rather than at the Experiment Station at Honolulu, besides our land is very limited. I think our work ought to be supplemented with work conducted by the plantations.

The next subject was Irrigation. The Committee on Irrigation had not prepared a report.

The Chairman—I have noticed in reports that have come from the Experiment Station, that they have endeavored to show, that we were all using more water in irrigation than the cane required. Professor Maxwell's figures on that subject show, that apparently they obtained the best results with about one-third of the water we use on Maui. I would like to hear what some of the Oahu planters have to say in regard to it. For instance, Dr. Maxwell, if I remember rightly, in his reports showed that at the Station about an inch a week would give them a better result—an inch of water a week over the whole surface—than they could obtain by any larger amount of water. We use on some of our plantations pretty near three times that amount, and get the best results,—that is anywhere from ten to twelve inches a month. Mr. Goodale is here, and probably will tell us what he thinks of it.

Mr. Goodale—We have followed a thorough irrigation of the field with about three inches over the entire surface under cultivation, and that is equivalent to about 87,000 gallons for each irrigation. We have lands at Waialua, which do not require that, but the greater part of our land needs that and sometimes very much more. It has been quite noticeable to people who visited the Waialua plantation, that a great many of our lands apparently required a heavy application of water. When a man is irrigating, by the time the fourth row is full of water, there is not water standing in the first. That is not the case in the lowlands of the Ewa plantation. I have myself seen water standing in seventeen rows at Ewa. This would indicate to me, that the Waialua plantation, which is well drained, requires a great deal of water, and I know that the application of one inch over the entire surface could not keep the cane alive. As a proof of this I would say that our average rainfall amounts to about three or four inches a month; if that rain falls all in one storm—if we have a three-inch rain storm—we may be able to shut down our pumps and stop irrigating for about six or seven days; but if we have anything less than a three-inch rainfall, the land requires water. It is very quickly shown by the curling of the edges of the leaves. I cannot understand how any such condition as that, which Dr. Maxwell has described, could exist unless the land is marshy.

Mr. Baldwin—I could never understand how he could give an inch a week, and keep the cane growing the way he did, especially as there is a sub-stratum of sand at the Experiment Station.

Mr. Scott—The best rainfall, we can have, is from ten to twelve inches a month. When we have less, the cane shows it, and if we have more than that amount, it is really more than the cane requires. I remember, that Mr. Morrison during his lifetime compared the irrigation of three inches a week with the rainfall of the Hilo district.

Mr. Eckart—A great many plantations, of course, put on a great deal more than one inch of water per week, and they have found in some cases, that it is necessary to put on more. Our average results for the last four years, with two crops of cane, have shown, that with Lahaina cane we got the maximum yield of sugar with three inches of water per week; one inch gave something like 22,000 pounds of sugar to the acre, and three inches gave four tons more, or 30,000 pounds. With Rose Bamboo cane the maximum yields were greatest with two inches of water per week, although three inches gave somewhat larger returns than where one inch was applied.

In the experiments, that were carried out some years ago by Dr. Maxwell, I feel certain, that he figured on his amounts of water differently than both Mr. Blouin and myself. When Dr. Maxwell stated, that two inches of water were applied per week, I am convinced, that he averaged up the amount of water for the crop, and that that amount was two inches per week. For instance, he may not have irrigated during some weeks, and in other weeks, to make up for the skipping of irrigations, he doubled the amount of water; so that his two inches would be the average per week.

In regard to what has been the practice at the Experiment Station since I have been there as a Director, I would say, that we have used two inches of water per week as a maximum in the two inch test.

The Chairman—Do you put that on regardless of what the rainfall might have been?

Mr. Eckart—Yes. For instance, if we are putting on two inches of water per week, we would stop with about an inch and a half rainfall, as that rainfall is distributed over the entire area.

The Chairman—Since our discussion, I have read over very carefully this morning, the Experiment Station Report, which is very interesting, and I find that the results for Lahaina cane are as you state. The tables are very full and complete and I would commend your report on irrigation to all the planters, as containing a precise statement of the whole thing—that is the experiments in irrigation at the Experiment Station. There they take into account the rainfall.

The strange thing to me has been, that the amount of irrigation as advised by Dr. Maxwell for all of his experiments was one inch a week or four inches in a month, whereas, as I stated yesterday, probably there is not a planter in the islands, but who would say, that the cane requires from ten to twelve, and even more inches of water per month—that has been the practice. We have found, in other words, that we have used about three times the amount of water that Dr. Maxwell recommended, gathered from his experiments. Your experiments just reverse this, and it is a little difficult for us to understand how these figures come out in that way.

We find it to be correct that the Lahaina cane requires more irrigation than any other cane we have on the islands, and Rose Bamboo requires much less than Lahaina cane.

REPORT OF COMMITTEE ON MACHINERY.

To the President and Members, Hawaiian Sugar Planters' Association, Honolulu, T. H.

Gentlemen:—Through the unavoidable absence from the Territory of the chairman and several members of your Committee on Machinery, the report this year may not be as comprehensive as has been the case heretofore, but I have prepared the following for your consideration:

It has been my privilege to have resided in this country since May, 1877, and during that period I have been more or less intimately connected with machinery, especially that of sugar mills; so it has occurred to me that a short sketch of the development and advancement which has taken place in that time, would indicate in some small degree the various steps by which we have attained to our present high standard of efficiency.

The year 1876 was the first year in which we enjoyed the benefits of the Reciprocity Treaty, and through that treaty a new impetus had been given to the sugar industry—a steady improvement having been the rule since then, in every department of the business. At that time no one ever dreamed that more than one 3-roller mill was necessary for crushing cane, and extraction was not often mentioned as a criterion of efficiency. What we did hear often was, "How many tons are you making?"—"Oh, about ten!" and, mark you, this referred to a whole day's work, although candor compels the admission that it was not a twenty-four hour day. But certainly it is a vast step from ten tons of sugar per ten-hour day, to as much as 100 and 300 tons in a twenty-four-hour day, which is now accomplished on some of our larger plantations.

When 8 cent sugar became a past experience, and all indications foretold a still lower price, it became obvious that we would have to get more of the sugar which was in the cane, into the market. The first improvement with this end in view was made in the year 1880, when a two-roller mill was placed behind the existing 3-roller mill at Spreckelsville, Maui. This could not be called a successful experiment, as great difficulty was experienced in getting the new 2-roller mill to take the feed, and therefore drier grinding, which was the object of the additional mill, was out of the question.

This difficulty did not prove an insurmountable one, however, for in 1884 a 2-roller mill was installed at Waiakea, which had a patent feeder, the invention of Mr. Alexander Young, then manager of the Honolulu Iron Works.

This combination was eminently successful, the results being far beyond any expectations. The percentage of extraction was raised from the seventies to eighty-five and ninety. This was such a large increase in extraction, that grave doubts were expressed as to the accuracy of the repots. Chemists came from Honolulu to verify them, and did so. Even then doubting Thomases were rife, and one fine morning the S. S. "Likelike" arrived in Hilo, with a lot of megass in bags, to put with a fair amount of maceration, through the new 2-roller mill at Waiakea. The engineer of the plantation sending the megass came along to see fair play. The result of this special trial was conclusive, and the plantation referred to, ordered a mill with a feeder at once. Orders then went to the Honolulu Iron Works so fast, that working day and night, they could not supply the demand, but had to send to San Francisco and have some made the same as the original. We called these mills "Maceration Mills" on account of the water used.

I well remember while they were yet new, how sceptical many were, as to their necessity. Mr. Alexander Young said to a plantation owner one day, standing behind his mill, "Mr. so-and-so, you are not getting more than 65 per cent. extraction with that mill of yours." "Sir," said Mr. So-and-so, "you say that again and will have you arrested." "Well, I would like to put in a mill to catch what is left," said Mr. Yound, and the planter felt badly hurt at the implication. He is still amongst us and may be here today, but he now has three 3-roller mills.

Maceration was such a decided improvement, that various combinations of mills were tried in the effort to get increased extraction. Some had a 3-roller mill with one 2-roller mill; some tried two 3-roller mills and one 2-roller mill; and others again three 2-roller mills, etc., but it soon became evident that some method of preparing the cane was necessary, so that the first mill would take its feed steadily and evenly, and discharge a blanket of megass, which after dilution, would feed to the second and third mills without baulking.

Rollers which were held absolutely rigid could only do good work with a feed of uniform thickness, but the then necessarily uneven feed was partly overcome by the application of the toggle springs to the cap bolts of the top roll. This, however, did not assure as steady a feed at the first mill as was necessary, and in our efforts to overcome this defect, we were shortly adding to our crushing plants, the Krajewski Crusher, the National Cane Shredder, and the

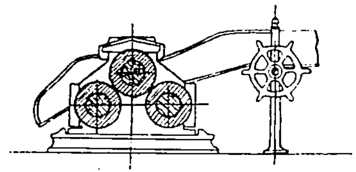
Smith Revolving Cutter; the first installation of each being placed at Pepeekeo, Wainaku and Waiakea respectively. Some of these machines are now a part of nearly every factory, and their value is beyond question. Some factories indeed, have installed both a cutter and a crusher, and many cutters, which were thrown to one side shortly after installation, have been since resurrected from the scrap pile, and are now doing duty nobly, thanks to Mr. H. Lorenz, who admired the knives the first he saw them at work.

We moved along the lines indicated for some years and our next marked improvement was destined to be imported from America.

After a short but comprehensive experience with the diffusion process of extraction, the Ewa Plantation Co. determined to discard this process and adopt crushing. In making their choice of crushing machinery, they concluded that the "Cora" mill, as built by the Fulton Iron Works, St. Louis, was the best and most effective on the market, so the company had Mr. Tenney, and Mr. Young of the H. I. W., proceed to St. Louis and order one. This mill, having three 3-rollers, with the top roll of each fitted with hydraulic rams, the pressure applied to the rolls being within immediate control, and a uniform known pressure being assured for cane and macerated bagasse, was a distinct advance over our previous combinations. The extraction rose from 90% up to 93%, and it was so necessary by this time to get everything possible out of the cane, that all interested desired such mills for their factories.

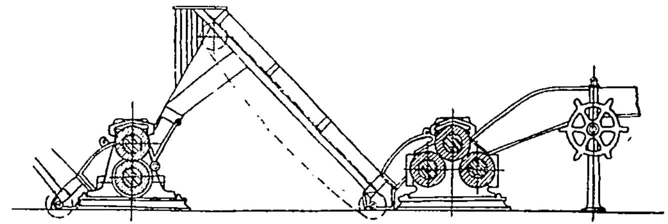
After a trial of one or two seasons this combination was found so satisfactory, that new mills were built, following the same lines, at the Honolulu Iron Works, under the direction of Mr. C. Hedeman, the then manager. This firm placed their first mill of this type at Honomu in 1897. Their initial venture proving as successful as the imported mill, was soon followed by many orders for similar combinations, for other plantations.

This combination (three 3-rollers) with the various feeders remained the standard, until the installation two years ago at Oahu Plantation of a fourth 3-roller mill, behind their three 3-roller combination. This installation was the first of its kind in the world, the mills being built by the Honolulu Iron Works, under the supervision of Messrs. H. Hackfeld & Company's executive engineer, Mr. Max Lorenz, and credit for its inception is due this gentleman. The adoption of this idea and its application is entirely due to the progressive spirit of Hawaiian planters and engineers and the results have amply justified their judgment. Increased capacity and better extraction with a minimum of maceration have been obtained. The decrease in maceration is obtained by taking



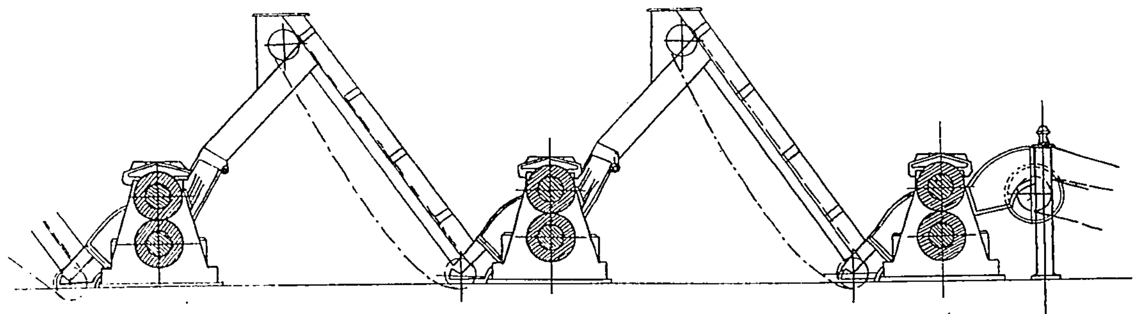
1877 — THREE ROLL MILL — EXTRACTION 75%

FIG. 1.



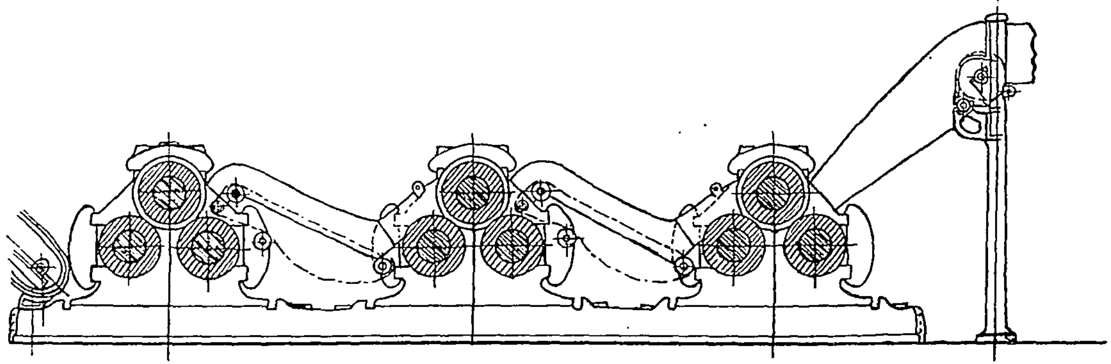
1884 — FIVE ROLL MILL — EXTRACTION 85–90%.

FIG: 2.



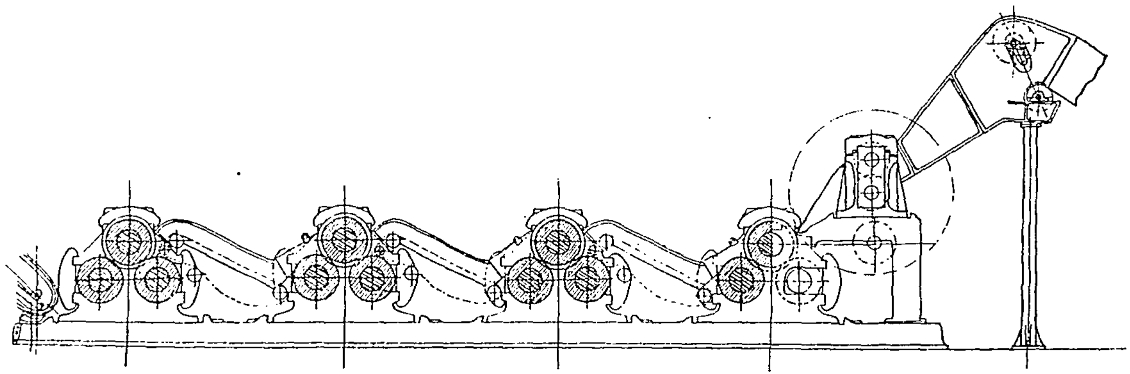
1890 — SIX ROLL MILL — EXTRACTION 88%

FIG. 3.



1894 – NINE ROLL MILL – EXTRACTION 90 TO 95%

FIG. 4.



1905 – TWELVE ROLL MILL – EXTRACTION 96%.

FIG. 5.

the thin juices from the fourth mill to macerate at the back of the first mill.

The advantages of this four 3-roller mill combination are so apparent, especially in the matter of increased grinding capacity and extraction, that Makaweli plantation on Kauai, has discarded their diffusion process, and has installed a similar outfit with the addition of a crusher, feeling confident that a commensurate saving will be obtained. Also the comparatively new factory at Puunene on Maui, is having a fourth mill added to each of its three 3-roller outfits, which will make their plant, two sets,—each composed of a crusher and four 3-roller mills. Other additions of a like nature are under way at the Honolulu Iron Works, or are in contemplation.

Figure 1 shows the 3-roller mill as used in 1877, the extraction being 75%;

Figure 2 shows the 5-roller mills as introduced in about 1884, the 2-roller mills being fitted with the Young system of automatic feeder, and having an extraction from 85 to 90%;

Figure 3 illustrates the 6-roller milling arrangement as first introduced at Wailuku in 1890, these mills being equipped with a Young automatic feeder system and their extraction being about 88%, or approximately the same as the 5-roller mill. The principal reason for the introduction of this type of mill at that time was to dispense with the returner bars which were a source of continual trouble and annoying breakdowns;

Figure 4 illustrates the 9-roller mill as first introduced at Ewa, in 1894. These mills were of massive construction and had powerful gearing; and while it appeared like going backwards and returning to the 3-roller mills with the returner bars and accompanying toubles, such a great stride had been made in the dimensions of shafts, returner bars, etc., in comparison with our former mill construction that this system of mills has been most successful and marked a new era in cane crushing machinery.

Figure 5 illustrates the 12-roller type of mill with the additions of the crusher and revolving knives for the preparation of the cane. This type of mill represents our latest ideas in mill construction and operation. The construction of this 12-roller mill is very simiiar to the 9-roller mill (Fig. 4) and the many advantages of this type of mill are well known.

First: The 12-roller mill as illustrated having same size of rolls, has about 25% greater capacity than the 9-roller mill with the same extraction;

Secondly: On account of the system of maceration possible with this mill, an extraction of from 95 to 96% can be obtained with half the maceration: in other words, an extraction of 96% can be obtained with 20% maceration while with the 9-roller mill from 30 to 40% is necessary to obtain the same results.

Thirdly: On account of the cane passing through the four mills less strain is necessary on the rolls and as a consequence less wear and tear on the journals, machinery, etc.

This last, figure No. 5, at present seems to be the limit in crushing machinery, but the increased results, you will notice, are not all due to heavier crushing—judicious maceration, which after all is a sort of crude diffusion process, has to be duly credited with a large proportion of the increase. Any further increase in extraction would therefore seem to be necessarily the outcome of crushing and diffusion combined, and I notice that several combinations of this nature are already in the market, such as the Naudet process, which no doubt all ow you are watching carefully from reports. As long ago as 1889, however, some of our island sugar experts had such combinations in mind, for in that year Mr. Alexander Young, then of the H. I. W., invented and patented his Steam Jacketed Parabolic Diffusion Tube a short description of which is attached) and a tube of this description was installed at Waiakea in 1890. The reason for discarding this apparatus is also given in the description, which was kindly furnished by Mr. Young.

While these improvements were being made in the crushing machinery of factories, equally great advances were made in the other departments. Our boiling houses are under such control, chemically and mechanically, as to bring the production of sugar in them into the category of exact sciences.

Evaporation has been improved both as to its results and economy, for where we used to have the vacuum pan only in 1877, since then we have had single and then double effects, are now using triple and quadruple effects, or one of the several film evaporators.

Among the latter, the "Lillie" is in the front rank. I consider this evaporator, when clean and working on clean juice, a device as good as any in the market. I have used one for four years and like it much better than I did the Standard effect. We can do more work with it to-day than it was guaranteed to do and it is much more economical in every respect. It has its faults, but so have all the others on the market.

Other improvements, such as Central Condensation Installations, the better entrainment facilities, superheated clarification, and others, would more properly come under the department of Manufacture, but I would like to note in passing, that the Weston Centrifugal, which was invented and perfected in these Islands by Mr. Weston, one of the old H. I. W. boys, is still the standard drying machine the world over. Of late it has been supplemented by evaporating dryers, such as the "Hersey." The advantages claimed for this additional process, are that it enables the sugar to keep better during the long journey which most of our product has to take before being placed on the market; shrinkage and loss is practically eliminated, and it allows inferior grades of sugar to be worked up to the shipping grade without fear of deterioration during transportation. Last annual meeting I made enquiries in regard to this method of drying, and from my observation of Olaa's experience last year, I have come to the conclusion that I needed one of the outfits, so am placing one this year. Attached will give report from Olaa as to results from this dryer.

All the work which we have hitherto outlined depends entirely on a portion of the factory to which I am afraid, we have not at all times given the consideration which it deserves —I refer now to the Steam Generators. True we have better and more economical boilers now than we used to have in 1877, but when we come to think of it they would need to be. Now-a-days, we add a pump here and an engine there, and put on a crusher and a few such other additions, but until the limit of forcing is reached we are often-times unable to add to, or increase our boiler battery. Several plants indeed from lack of room to extend, or from having their battery in a poor steaming location, have had to supplement their normal boiler capacity, by adding a forced draft outfit to their boiler room.

The class of boiler used in nearly all our sugar factories, is of the horizontal, externally fired, return tubular type. But comparatively few factories are equipped with the water tube boiler. I myself think that this standard boiler (usually 7' dia.x20'1"th.) is the best boiler we have for pressures up to 100 pounds but for higher pressures no doubt, the water tube boiler is more suitable. This standard tubular boiler is recognized in the engineering world as being one of the most efficient steam generators there is. It has many points in its favor from the point of view of a sugar mill operator. It carries a large supply of water, which conserves the heat, has ample steam space, which allows the furnishing of dry steam, and on account of its implicity of construction, cleaning and repairing can be easily attended to.

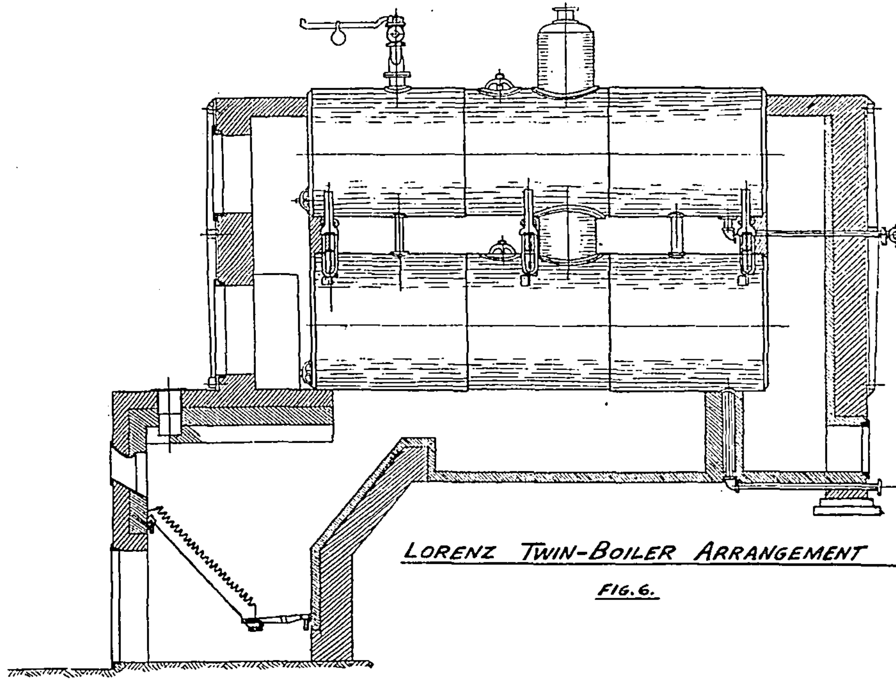
A novel arrangement of multi-tubular boiler setting has been lately introduced by Mr. M. Lorenz, and installed at Oahu and other plantations, in order to save valuable floor space and expensive brick work. Two tubular boilers have been set, one above the other, and are connected together as far as steam connections are concerned, to one steam drum; the feed for both boilers is delivered to the upper one, the lower boiler getting its supply from an overflow pipe from the upper one. The upper boiler therefore will always have a fixed quantity of water in it, and the feed for both boilers is regulated by the requirements of the lower one. Excellent results have been obtained at Oahu Plantation with this arrangement of setting, in which one furnace supplies heat for the twin boilers.

Figure 6 illustrates the Lorenz system of twin boiler arrangement, the main object of which is to reduce the floor space required by the multi-tubular boiler and further to permit of present boiler installations being doubled without the necessary additions to buildings, changing of flues, brick work, etc., etc.

Before leaving the subject of boilers there is another point to which I would like to call your attention. Has it ever occurred to you, gentlemen, how few boiler troubles we have had in these Islands, and the consequent credit which is due to our engineers? We frequently read of boiler explosions in other countries, and on the mainland, where they have licensed men and insurnce supervision, but I have yet to hear of an explosion on these Islands, either in the sugar factories or in the Inter-Island steamers, during my 28 years' residence here. This record speaks volumes for the care and efficiency of our engineers, who labor with a class of help, and under circumstances which are often trying to state it mildly. No license law that was ever conceived, or could be conceived, would insure us any better record than we have already, but might force men on to us who were not careful, although they might be otherwise competent.

Our Inter-Island transportation facilities have kept pace with our needs and the machinery and equipment of these local vessels is modern and up-to-date. Those of us who had to travel on schooners and on the first steamers which were placed in this trade, must acknowledge that now traveling is comparatively speaking luxurious, and has certainly been safe. Turning to freighting, I believe that I am conservative in stating that our method of shipping sugar by wire chutes, at different open road-stead landings, is more efficient than it is at any other place where it is used; cost of shipment has certainly been reduced by it. Wire chute landings here handle, as an ordinary day's work, at the rate of 50 tons of sugar per hour, and one is in course of erection at Onomea, in the Hilo District, which will handle about 70 tons per hour. The best work, which I can find being done at similar landings elsewhere, runs from 30 to 35 tons per hour. Better work may have been done but I have been unable to get a record of it.

Machinery has taken its place in the fields to a greater extent than ever before. Labor has been saved by the different mechanical cane loading devices, and I trust the day is not far off when we will have a harvester which will at least cut the cane, even if it does not combine the operations of cutting, and loading ready for transportation to the mill. I



LORENZ TWIN-BOILER ARRANGEMENT

FIG. 6.

feel confident that were it not for the stones on Waiakea we could cut all the Caledonia cane by machinery.

No machinery report can be complete unless the marked saving effected by the use of oil fuel over coal, in pumping plants and locomotives is noted. I have been fortunate in getting some practical figures from Mr. J. N. S. Williams of Puunene Mill, and J. A. Low, of Honolulu Sugar Company, bearing on this matter and submit them attached as received.

I also beg to submit the following individual contributions:

Bagasse Diffusion ....Alexander Young
Setting of Mills.................................An Engineer
Fuel Oil.....................................J. A. Low, Oahu
Fuel Oil.............................J. N. S. Williams, Maui

Honolulu, T. H., Sept. 18, 195.

Chas. C. Kennedy, Esq.,
Waiakea Mill,
Hilo, Hawaii.

Dear Sir:—The steam jacketed parabolic diffusion tube for the diffusion of bagasse after receiving its final crushing in the roller mills, was invented and patented by me December 31st, 1889. It was erected and operated at the Waiakea Mill, Hilo, Hawaii, in 1890.

The tube was about 54 inches diameter, deflected downward in parabolic form, it was packeted at intervals for steam to maintain the liquid at the desired temperature in the tube throughout its entire length. The tube was circular and smooth inside so as to offer the least possible resistance to the trash in its passage. It was constructed as nearly as possible to the curve an endless chain with sufficient sag to it would take if hung over two pulleys placed at the proper distance apart.

The diffusion water was thrown into the tube at the end where the trash was continuously delivered and after percolating through the trash which moved in an opposite direction for the whole length, flowed off near the end where the trash entered as delivered from the roller mill trash carrier.

The reason for its operation being discontinued after a mere trial were: (a) That the gearing for driving the endless chain of skeleton discs was fault yin construction and inadepuate to perform the work required, (b) it was contended in those days by many experts that the additional sugar to be obtained by diffusion o fthe trash over that obtained by maceration would not compensate for the outlay for such a diffusion apparatus and the handling of the trash to make it dry enough for fuel again; (c) the apparatus was expensive in the first place and after due deliberation it was decided not to spend the additional money required to make the necessary alterations to make it effective and economical in its work.

Yours very truly,

ALEX. YOUNG.

SETTING OF MILLS TO GET THE BEST EXTRACTION.

BY AN ENGINEER OF TWENTY YEARS' EXPERIENCE.

I must say that I do not know of any "hard and fast" rules for the proper setting of mill rollers to obtain maximum good results; the difficulties in the way of such setting are, in the writer's estimation, insurmountable.

In common with others, I have seen many such rules which were guaranteed to solve the whole question of "How to do it," but these solutions nearly always emanated from persons of limited experience as mill men, or from those who were never conspicuous for phenominally good work.

A train of mills consisting of less than ine rollers with a preliminary adjunct such as revolving knives, or crusher, is no longer worth considering and a fourth set of rolls has proven its value beyond question; but even this addition does not help to a fixed rule for mill setting, and the person who can so adjust his mill at the beginning of a grinding season as to have it run unaltered during the whole crop, and give best results, has not yet appeared.

Let me give an illustration to establish this point. The manager of a plantation orders his engineer to be ready to grind cane on a certain date, and adds that he would like to pass through the mill 500 to 900 tons, or some other specific quantity of cane, as the case may be, every twenty-four hours. Obviously the thing to be done is to adjust the feed roll of No. 1 mill, so as to take the required amount of cane, but just what that adjustment will be cannot be determined while the mill is idle.

The structure of the cane is the factor which determines this adjustment, but if the rolls are set so that any further closure will cause the mill to refuse the feed, the proper adjustment has been made and all has been done that can be done to give roll No. 1 its proportionate amount of work. The first rollers of each of the following mills must freel yadmit the bagasse as it reaches them in turn, each having the same careful adjustment as No. 1 roll of the first mill. These conditions are absolute and easily reached. The proper position of the third roll in all except the last set in any train of mills, depends likewise on the character of cane being ground. The apparent stress on mill, careful inspection, and (if possible) chemical analysis of bagasse, all help to a conclusion and the rolls are fixed.

This might be a proper moment to take careful measurements and formulate a rule, but in less than twenty-four hours the whole thing will be dis-arranged. Intermediate and ultimate mills are refusing their feed, fibre in the cane has run up to such an extent that the feed is too heavy, or, the cane is soft with a non-resistant fibre and is what might be termed squashy, becoming more so with each operation until all tenacity is gone, and without alteration, the mills might as well be expected to grind mud-press cakes.

The first condition is easily met by opening the feed rolls. The second condition will not permit such an operation, for, if the roll is pulled back, far enough to take such feed, carrying a fair degree of maceration, the bagasse enters the mill so wet that not only will the back rolls spit incessantly behind, but the bagasse will enter the fire room carrying such excess of moisture as will materially reduce its fuel value, and the extraction has dropped off also. Without suggesting the remedy for this last condition, enough has been said to show that to meet either it, or the first condition, the mills have to be readjusted, and until conditions change, the "hard and fast" rule may be turned faced to the wall.

Surface speed of rolls, depth of feed, etc., are other questions not now considered.

The mill of today has made possible a high degree of extraction, and has brought with it increased responsibility to the man in charge. Best results are obtained by those who are most observant and are readiest to adjust the mill to suit the character of the cane upon which it is working.

FUEL OILS.

C. C. Kennedy, Esq.,

Acting Chairman, Committee on Machinery,

Hawaiian Sugar Planters' Association for 1905.

Dear Sir:—Replying to your favor of August 15th, last, requesting a writing from me on fuel oils, both as to their good and bad features, the final value as compared with coal, and the economy, including the labor saved, I beg to submit the following based on the experience of the Honolulu Plantation, and my own knowledge of the subject.

Introduction.

In the beginning of 1903 the question of substituting fuel oil for coal at the pumping stations of the Honolulu Plantation Co. was carefully considered. Cost of installation, safety in operation, expense of boiler repairs, saving in labor and saving in fuel expense, were the main item considered. This paper has to do with the last three items mainly, of which the saving in fuel cost is by far the most important. In order to determine this, the cost and quality of each fuel must be at least approximately known, and we give below such data as was then available, our preliminary estimates, and lastly the results of 18 months' experience with oil fuel compared with previous results with coal.

Coal.

Australian coal from the Duckenfield and East Greta Mines was principally in use at all of our pumping stations up to 1903, and cost this company an average during 1902 of $7.89 per ton of 2,240 pounds laid down at the pump. The coal from these mines had been determined upon as the cheapest in the market after having made a series of evaporative tests of seven different coals that were being purchased by this company, the first cost of coal and evaporative power being considered in arriving at this conclusion. Several of the coals tested cost less money per ton but their evaporative power being less, established the above grades as the most economical. The tests were made under ordinary working conditions and no special attempts were made to secure "results." We found that one pound of the above coals would evaporate eight pounds of water from and at 212° F., or in other words it cost $0.0004375 to evaporate one pound of water with either of these coals as fuel.

Oil.

The fuel oil offered to this company under contract was to be 14° to 20° Beaume at 60° temperature Fahr. and deductions were to be made for impurities exceeding 1%. Cost delivered at pumping plants was to be $1.45 per barrel. Oil was to come from the Coalinga oil fields, Fresno Co., Cal., which oil is exceptionally free from asphaltine and such impurities as sand, water, etc., and has, from laboratory determinations some 18,840 B. T. U. A sample lot of ten barrels of this oil was secured and one of the boilers at one of our pump plants changed to an oil burner and an evaporative test was made under ordinary working conditions as had been done in the case of the coal test above mentioned. This resulted in showing an evaporation of 15.01 pounds of water per pound of oil from and at 212° Fahr., or it cost $0.0002922 to evaporate one pound of water with fuel oil.

Preliminary Comparison.

Here then we had a basis on which to compare the fuel item of our pump expense which showed that the oil fuel cost

66.8% of the coal fuel. There remained to compare the item of boiler repairs and labor, and in this case it was necessary to rely upon the testimony and experience of others who had installed oil fuel in their power plants, all of which pointed towards but a slight increase, if any, in the first item, (boiler repairs), and a substantial saving in the latter (labor). Upon this showing, the Honolulu Plantation Co. then installed the oil fuel system in all of its pumping plants, and we now come to a comparison of the actual results with both fuels over an extended period when reduced to cost of lifting one million gallons one foot high, which is the important point with all pumping plantations.

Theoretical Comparison.

Practically the same result is obtained by the following theoretical comparison:

The oils we have been using show an average density of 18.5° Beaume; a flash test of 205° F., and they produce approximately 18,840 heat units (B. T. U.) per pound.

The Australian coals we used before the introduction of oil showed an average of 9,9971 B. T. U. per pound, which is only 52.9% of the heat units obtained from a pound of our oil.

Taking the cost into consideration we have: One barrel of oil (42 gallons) at .9440 specific gravity weighs 330.6 pounds, which at the average price of $1.45 per barrel is equivalent to .438c. is equivalent to .00002325c. per heat unit, and one pound of coal, or 9,971 heat units at .352c. is equivalent to .000003530c. per heat unit. Thus showing the cost of oil heat units to be 65.86% of the cost of coal heat units.

Practical Results Compared.

From pump records kept at all of our pump stations we have the average cost for coal fuel for the year 1902 to lift one million gallons water one foot high. These figures are based on pump displacement in which a deduction of 5% for slip has been made.

From similar pump reports we have the cost to lift one million gallons one foot high for oil fuel, $0.02904. This is the average of 18 months, and figures are based on pump displacement, and the 5% deduction made for slip as above. In a word fuel oil costs 66.1% what coal cost us, which is practically what our preliminary test gave us. Or to put it in another way, one ton of our coal was equivalent to 3.67 barrels of our oil, and whenever we can land a similar quality of coal at our pumping plants at $5.31 per ton then there is no saving in oil fuel at $1.45 per barrel.

Since 1903 this company has been basing all pump expense items on the quantity of water actually delivered as determined by weir measurement. Previous to this time, however, we based our figures on pump displacement, with an allowance of 5% for slip, and in order to make comparison for the two periods it was necessary to take pump displacement as a basis in both cases.

Labor Saving.

The installation of fuel oil has reduced the labor at each pump station that was regularly employed while coal was used, to some extent. This saving when considered with the total expense of any one pumping plant however, becomes insignificant, not being more than 2 or 3%. In large power plants where a small army of coal passers had been employed, a substantial saving could be shown, as the same force of men can care for a large oil system as are required about a small one. For this reason no very important saving in pump expense has been made through reduction in labor, except that the class of labor which we have in firing, maintain a more steady steam pressure in firing oil than when firing coal, which is very gratifying.

Boiler Repairs.

Repairs to boilers have been increased with oil fuel owing to the burning out of tubes. This item of increased cost, like the saving in labor above mentioned, does not effect the total pump expense to any marked extent. In the 13 boilers in use at our four pump stations we have in two years replaced approximately 70 boiler tumes. There is also a slight increased cost in the repairs of furnaces. All these increased repairs together will just about offset the decreased labor account, and we therefore conclude that this company has effected a saving of from 33% to 35% in pumping expense through the installation of fuel oil.

Installation.

The cost of installing an oil burning system is comparatively small, amounting in our case to an increase of about 1½% in the cost of the pumping plants. The outlay included cost of spur tracks, storage tanks for 6 days' run, a supply tank set below the level of the burners in the furnaces, oil pumps, piping and euipment, and the expense of changing furnaces from coal to oil burners. Both the Babcocks and Wilcox and Heine obilers are in operation at our different pump stations and we have found no material advantage that either make has over the other in efficiency with oil fuel. The type of burners used does not seem to make any great difference. We have tried the Morrissy, Low and Owens makes and are of the opinion that they are all of equal efficiency, and as long as the oil is thoroughly atomized and the baffle walls in the boiler tubes are properly set to control the draft, and the furnaces are of sufficient size, and the oil is intelligently handled, you can get the same results with any of the first class burners on the market. The claims of increased efficiency that every patentee makes for his particular burner are due to the fact that after a man puts in his own patent burner he will always take more interest in the machinery under his care and bring the entire plant up to a greater efficiency, and, of course, he immediately gives all the credit to his patent burner. As before stated a properly designed furnace and intelligent firing will give results such as we have obtained with any of the first class burners.

Locomotives.

Oil fuel has also been installed in the locomotives of this company, and resulted in some saving in fuel expense. We have no records of miles run by locomotives or of freight handled, and the only way to make a comparison at all was to compare the locomotive fuel bill for each month after the oil had been installed, with the same month of the year previous when coal was used. We found a saving of about 8% in the fuel item. The saving in cost of fuel was not the important point in this connection. Doing away with sparks from coal burning locomotives and reducing the danger of cane fires was by far the greatest benefit derived from this change. We look for a greater saving in the fuel item during the coming season due to changes being made in our boilers.

Good and Bad Features.

Under this heading my general knowledge of oils comes from my study of the question, and experience, and from arguments and statements made by representatives of oil companies, and such data as I have read on the subject.

Having now answered all your queries on the good features in the way of the profitable end of the use of fuel oil, there remains but to point out some of the mistaken conceptions regarding its value and to mention some of the objectionable points in regard to its use, some of which we have learned through experience. Care should be taken in the use of oil so as to secure a uniform grade, especially with reference to the flash point as it would be very dangerous to change suddenly from a high flash point oil to a low flash point oil without the knowledge of the operator; when once a furnace and burners were arranged for the former. Herein lies the chief danger in the use of any oil which varies greatly in its volatile content.

An accident occurred by the blowing out of the side wall of one of the mill boilers of the Honolulu Plantation Company, due to just such conditions, namely, a sudden change in firing oil of 16° Beaume flashing about 200° F. to oil of 21° Beaume flashing 134° F. If the affair had been reversed and the change from a light gravity oil to a heavier gravity, no accident could have occurred because of the burner being set for the thinner oils. Generally the higher gravity oils are always liable to contain some of the more volatile compounds which may at any time give off an inflamable vapor even at the ordinary temperature.

With the class of labor which we have doing the firing of oil on this plantation, I feel my responsibilities are much lessened and the dangers to property decreased by using the high flash test oils. One or two other accidents have taken place on these Islands where the higher gravity oils have been used, and I know of none where the lower gravity oils were in use.

The fuel oils of California do not have uniform quality and vary considerably.

There are a number of causes which result in greater or less value of fuel oils, principally the moisture foreign matter (asphaltine), sand and sediment. In certain localities of California some grades of oil can be purchased very sheaply and at figures far below what is being paid for oils shipped to this country; this is due to the fact that they contain only a small percentage of the higher distillates, which are not sufficient to make them profitable refining oils, yet increase the danger in using because of the low flash point resulting from this small percentage of these extremely volatile compounds.

It is well known according to chemical formulas that pure high gravity oils contain more heat units per pound of fuel than do the low gravity oils, and the conclusion is sometimes drawn that the high gravity oils are for this reason more valuable as fuel; but practice disproves this, for the fact is, when buying a barrel of low gravity oils we secure more pounds of fuel than in a barrel of high gravity oil. Bearing out this point we note the experience of this company with the two classes of oil which it has used, namely, the high gravity oils from the Union Oil Company, and the low gravity oils from the Pacific Oil Transportation Company. For two weeks this company received oil from the Union Oil Company's tanks during a temporary shortage of the Pacific Oil Transportation Company. This oil was much lighter, being about 20° to 22° Baumé, and had a lower flash point. We made careful note of the daily consumption of oil at each station and found it o remain practically the same. In one case an additional barrel or two was used on several days. On taking an average, however, for two weeks, we found the cost of lifting one million gallons one foot high was within one one-hundredth of a cent of what it had previously been with the heavier oil.

We explain this, as before noted, by the fact that in a barrel of 16° to 18° Baumé oil we secure more pounds of fuel than with the lighter oil. Also the Union Oil Company's oil came from Santa Barbara, and the oils from that district generally contain from 7 to 12% asphaltine and a slight percentage of foreign matter and water in solution. The asphaltine weighs but from one-third to one-quarter as much as the oil it displaces and hence reduces the weight materially, besides having only about one-quarter the calorific value of the oil. It is such practical results as these where the different oils have been used under exactly similar conditions that have educated people who use fuel oil, that it is valuable only in the same degree as coal, and a conclusion as to its value should only be drawn from a test showing the pounds of water which one pound of fuel oil will evaporate, and that no standard of gravity or flash test will establish the relative heat producing qualities of an oil; therefore, the percentage of impurities in crude oils will vary to such an extent that comparisons of heat value of different oils will be of no value whatever unless made under exactly similar conditions.

Respectfully submitted,

JAMES A. LOW.

Aiea, Oahu, October 24th, 1905.

Puunene, Maui, Aug. 20, 1905.

C. C. Kennedy, Esq.,

Waiakea Mill Co., Hilo, Hawaii.

My Dear Sir:—Replying to you esteemed favor of the 16th inst., I take pleasure in handing you the following concerning California crude oil as fuel. We now use this fuel in our pumping plants, locomotives, steam plows, machine and blacksmith shop and mill, when required, with great satisfaction. The figures given are taken from our records of the work at our largest pumping station, which is equipped with two Allis Chalmers Riedler Triple Expansion Pumping engines of 10 million gallons capacity each. Boilers are of the Sederholm type, fitted with economizers an dall modern improvements.

Year 1902, coal used only, cost for fuel...........$18,015.56
Water delivered to 225 feet elevation.. 2147.5 millions of gallons
Cost of fuel only per million gallons lifted one foot high....3.73c
Year 1904, oil used only, cost for fuel...............$19,498.67
Water delivered to 226 feet elevation..3047.7 millions of gallons
Cost of fuel only per million gallons lifted one foot high..2.83c

Taking the cost of coal as the basis, these figures show that in oil firing the fuel cost is 75.87% of coal firing.

Labor Saved—This depends entirely on the size of the plants, as it is clear that a small plant employing only one fireman per watch cannot reduce its pay roll by using oil instead of coal; but on a large plant the saving may be very great.

The following figures are from the records of the above mentioned pumping plant:

Year 1902, coal firing, total pumping hours........... 5948
Wages paid for station, inclusive of engine tenders and firemen $6597.96
Cost of wages per hour....................$1.09
Year 1904, oil firing, total pumping hours............. 4048
Wages paid for station inclusive of engine tenders and firemen $2647.05
Cost of wages per hour....................$0.65

Taking cost of coal as the basis these figures show that the pay roll of a large station when firing oil may be as much as 40% less than when firing coal.

The combined saving in labor and fuel is then as follows:

Year 1902, coal firing, cost of fuel..................$18,015.26
Wages 6,597.96

$24,613.22

Cost per million gallons lifted 1 foot high........5.09 cents
Year 1904, oil firing, cost of fuel...................$19,498.67
Wages 2,647.05

$22,145.72

Cost per million gallons lifted 1 foot high........3.21 cents

Which figures show that the combined saving in oil firing as against coal firing, (taking coal firing as the basis of comparison), amounts to 37%.

This large combined saving can only be realized on a large plant, but the saving in fuel cost can be obtained on any sized plant.

We have not been able to detect any undue deterioration in our boilers or furnaces since using oil as fuel, and I am therefore not able to bring forward any bad features, on the contrary the use of oil in locomotives for plantation use ,tends to reduce the risk of cane fires as there are no sparks; it is much easier for the men to handle and consequently the locomotives are kept in better shape with less labor.

Trusting that this will prove useful, I remain,

Yours very truly,

J. N. S. WILLIAMS.

Mr. David Forbes—I would like to ask for some information in regard to the question of fuel oil. I would like to know the experience of some of the gentlemen using fuel oil as to whether they apply it to the steam plows. Would it result as well as it does with the locomotives?

Mr. Mead—Mr. Williams states that he used it on his steam plows.

The Chairman—I do not think there is quite so much saving on the steam plows as there is with its use in connection with locomotives. As you see, there is some difficulty in transporting the oil around into the field. Of course fuel oil does save labor in most branches of the plantation work. I do not think there is really any labor saved in its use on a steam plow, but still our figures show that there is a saving in it. Mr. Goodale, do you use oil on the steam plows?

Mr. Goodale—No we do not. As the fire box of a steam plow engine is quite small, I think there would be some trouble about properly protecting the front of the boiler. I think that has been one trouble with the locomotives on account of the smallness of the fire box, and the fire box of the steam plow engine is still smaller than that of the ordinary locomotive.

Mr. Scott—Mr. President, I would like to ask Mr. Goodale or some of the other gentlemen who are using the Lillie effect whether they are easier kept clean than the ordinary Standard effect.

Mr. Goodale—At Waialua we had a great deal of trouble with our Lillie effect in keeping it clean. The machine when it was sent out had a capacity of 250,000 gallons, but it never did it after the first three or four days. Then we objected, and an addition was made to it amounting to about 50% of its original capacity, making it 375,000 gallons capacity by Mr. Lillie's method. When we started it the representatives of the Honolulu Iron Works came out and made a very careful test of it, and during the first week's run it did work up to its capacity, but there was a continual falling off in its capacity from that time on. Every year since we have used it, we have stopped once during the season and gone through a thorough cleaning process. We boiled it out with soda and muriatic acid, then allowed it to stand as long as possible full of vinegar, then we drew that out and thoroughly cleaned it. I do not know whether there is any difference in the quality of the juice or substances which these juices contain that formed scale, or what it is, but we have a very hard, flinty scale on the second, third and fourth effects. It is very refractory. On the first effect we have a sort of a sliding mud that is very easily removed on Saturday night and Sunday. The labor of scraping the tubes is very great. It takes as many men as can possibly work in the effect all day Sunday to clean the tubes and then they are not cleaned satisfactorily.

Mr. Baldwin—Our Lillie effect is the largest on the Island I think. It is a very large apparatus. It has not done the work that it was guaranteed to do, not by any means, and we have had a great deal of trouble with it. We have overcome some of the difficulties. Our engineers have studied it and have found where they could make improvements here and there, and now it is working very much better than at first; but I rather think that if we were to build a mill again, that we would build a Standard effect. The principle is simple and perfect, and there is a great deal about the Lillie effect which does not work well.

Mr. Scott—I had to renew my triple effect during the last two years, and I put in a Standard effect with 40% more heating capacity than my old one was, and this year I found that there was a great deal of difference in our juices, that is, we have had no difficulty in keeping the first and second pans clean, but it has been almost impossible owing to the material in the juices to keep the third pan absolutely clean. It would form even with the use of the strongest vinegar reinforced by sulphuric acid and other ingredients. Whether it was owing to the liming of the lands or a difference in the cane, that is in the Yellow Caledonia cane which we have mostly—I do not know, but we have had difficulty and have sent samples of the scale to the Dearborn Company. They sent me out a barrel of compound that was used largely here on Oahu, but it did not meet our requirements. We sent on some of the scale to Chicago and had it analyzed there, and they sent out another compound, but we only received it on the completion of the crop so that I cannot say how it may act,—so I cannot say whether we shall be able to keep control of the scale or not, but there is a great difference in our juices from what they were when we were working largely with Lahaina cane.

Mr. Goodale—There has been a much greater loss by entrainment than we expected, and that increases as the machine gets old.

Some misunderstanding has arisen over the time appointed for the reading of the Experiment Station report, and Mr. W. O. Smith kindly volunteered to fill up this time with a talk on tobacco culture.

Mr. Smith—I would like to say a few words on the matter of tobacco culture. Years ago the subject was discussed at a meeting of the Planters' Labor and Supply Company, and when Mr. Jos. Marsden was sent on his expedition to India, Goa, Java and Sumatra, he looked into the subject and brought back from Sumatra quite a quantity of tobacco seed, which he said was from the various varieties of tobacco grown in Sumatra, and it was represented that for many years Sumatra had labored under the same difficulty as these islands in regard to the difficulty of obtaining a marketable kind of tobacco, and it was for a long time considered almost a useless undertaking. It was said that there was too much saltpeter in the soil, and other things. Finally they obtained a good grade of tobacco, and now, and for many years past—ten or fifteen or twenty years—they have developed a large export trade in tobacco, the tobacco being used mainly for wrappers.

We are now going to have the Philippines to contend with. Their main industries are hemp, tobacco and sugar. It has been represented that the capacity of the Philippines for sugar development is very limited; on the contrary it has been represented by disinterested persons that the possibilities are great, but the Philippines will always be a great competitor of these islands, unless we get some other industry besides sugar to depend upon. Their three great industries are hemp, tobacco and sugar, besides other incidental industries, and they have large forest possibilities there of lumber, timber and wooden materials, which may be very valuable in the market; but they have three feet to stand on, and when adversity touches one, they have the other two.

We have had the rice industry. That is now in a very bad way. Perhaps many of the sugar planters may not realize how serious the decadence of the rice industry is, and what it means to these islands, particularly to Kauai and Oahu. I am connected with the Bishop Estate which has rice lands on this island, for instance all through the Koolaus and around Waialua and through Ewa, and I can say that the property of Mr. A. S. Wilcox of Princeville has been turned mainly into rice producing property rather than sugar, but that with the very low price of rice, and their inability to obtain Chinese laborers, the industry is in a very bad way. It has affected the Hawaiian people very seriously. In many cases most of the lands belonging to the common natives were rented out to the rice growers, and they got good revenues that way. The Chinese mix with the Hawaiians more than any other alien race who have come here, and they have been a great benefit to the common native in helping to support and to maintain him.

To take the matter of the common retail trade at Honolulu, and its environs about Honolulu—it has been very much hurt—not one dealer, but very generally. Hard times have affected it, and there have been other incidental matters which have affected Honolulu. For instance, the steam carrying trade, in supplanting the sailing vessels. The big vessels that come here now bring all of their own supplies, spending only $300 or $400 a month here where the sailing vessels formerly spent $3000 or $4000 a month in Honolulu alone.

It remains, however, that we are coming down to the fact that we have only one industry to depend on, unless other things can be developed. The pineapple canning has become very successful, and that is a very hopeful thing.

Mr. Bruner and Mr. Louisson are still making success with coffee, but tobacco, which is one of the greatest commodities of the world, is still in its infancy. It is said that there are many millions of people who use it more than any other food product. Of course there is a great consumption of rice, and there are millions that use potatoes, as well as a great population of the world who use the wheat and grain products, but universally the world over, tobacco is used, and there will be no detriment in the slightest way to give some attention to the tobacco industry as well.

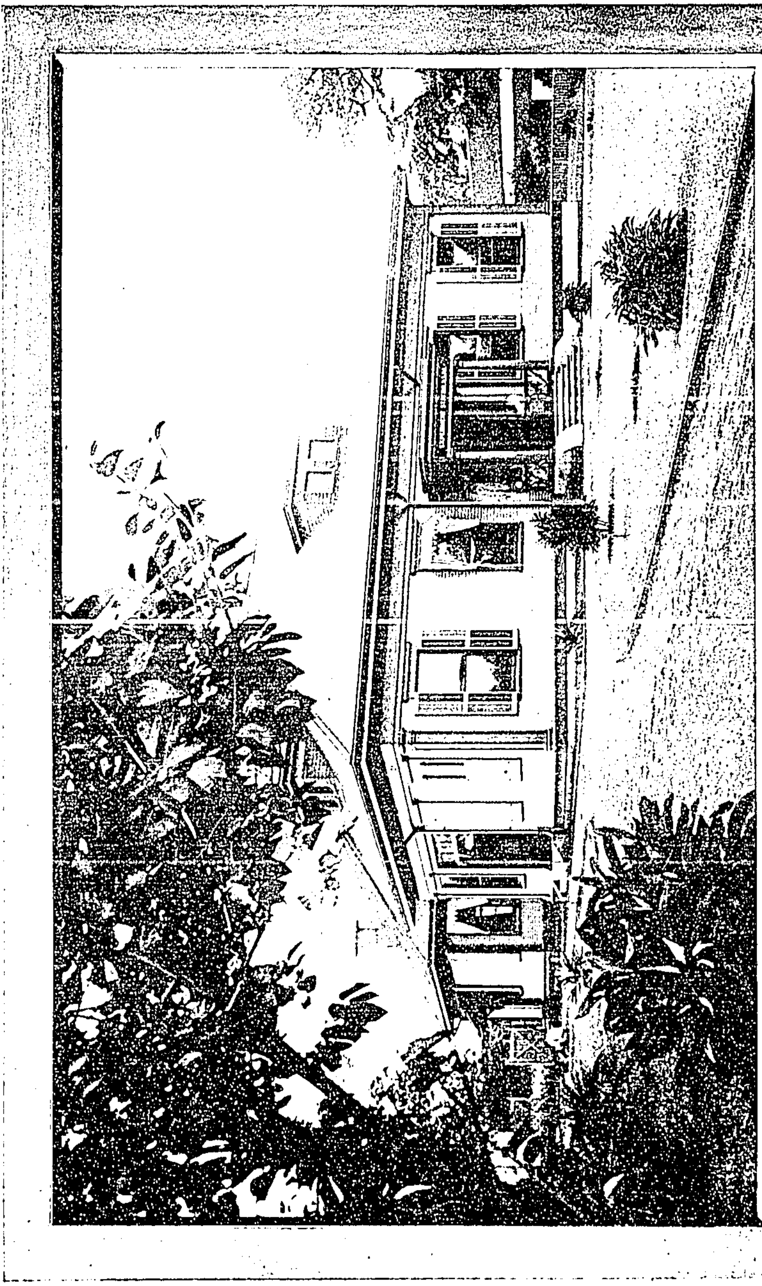
The Chairman—I think most of the planters are giving it attention already.

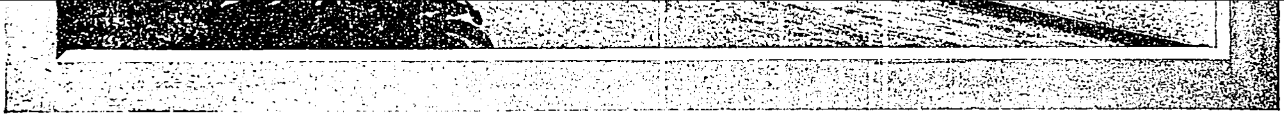
Mr. Smith—Then I will simply emphasize that a little further. I am very glad if that is so—that most of the planters, as you say, are trying it, but I think that isn't correct that most of the planters are trying experiments in tobacco culture. I think that a very few are trying it—in fact just a few on Hawaii and a few in other places.

Mr. Jared G. Smith of the United States Experiment Station has given careful attention to the soil suitable for it, and experiments in tobacco are being conducted now by him; but there should be more general attention given to the matter of tobacco culture, so that many lands which are not suited to cane culture could be thus used, and even portions of the cane land might be used for that purpose. But we are in a very bad way in regard to our labor—that is common employes—in having to depend simply upon the one production of sugar. The population, which would find employment in some of these other industries would help to make a resident population, so that at times of need they would be available for the sugar industry.

I hope personally that this matter of attention to tobacco culture and the experiments, which are being made will be thought of more seriously than ever, for it does seem to be one of the possibilities, which may help us in many ways, and help us in our competition with the Philippines, which is bound to come. We may oppose the reduction of the Philippine tariff all we have a mind to, but in the end we have got to compete with that country which has got three great industries to stand upon, and we have only one.

Last Saturday I went with Mr. A. S. Wilcox, who has given some thought to this subject, up to the United States Experiment Station, where I was surprised to find a large number of varieties of samples of tobacco which Mr. Smith had there, and there





EXPERIMENT STATION H. S. P. A.
Portion of Laboratories and Offices.

was a gentleman there from the mainland—a dealer in tobacco—who was very conversant with the subject. They have been making some cigars which are really a very great improvement upon anything which has been accomplished in that line of work here before.

Fifty years ago down at Kekaha, Kauai, Mr. Archer, Mr. Gruben and Mr. Knudsen when they were young men, lived there, and Mr. Archer for years made experiments in making cigars, and lost all he put into it. A few have tried it since. The time has now come, however, with the experiments that are being made with our cigar industry, when we should pay all the attention that is practicable to the matter of tobacco culture, and see that we get out of this deplorable condition of having but one industry to depend upon.

Reports of Committee on Experiment Station.

To the President, Board of Trustees, and Members of the Hawaiian Sugar Planters' Association.

Your Committee having charge of the Experiment Station begs to submit its Report for the twelve months ending September 30th, 1905.

ORGANIZATION.

At the time your Committee submitted its last annual report the Experiment Station was being thoroughly re-organized and its usefulness extended. A new division, that of Entomology, had just been established and another, that of Pathology and Physiology, was in course of organization. The serious losses occurring to plantations through the depredations of insect pests and of fungus diseases made the organization of these two new divisions a matter of paramount importance to the sugar industry in Hawaii, and whilst their establishment was looked upon as being, to a great extent, purely speculative, it was felt by practically all representatives of sugar interests that it would be suicidal to continue existing conditions without strenuous efforts being made to satisfactorily combat the pests and diseases complained of and thereby place the sugar industry on the same plane of production that Hawaii had enjoyed for years previous to 1903. The Station under its reorganization is now in thorough working order, and the experiments and investigations so far conducted are producing practical results.

PUBLICATIONS.

Besides the large number of Bulletins and Reports recorded in the Division reports as having been issued during the period, it was decided to reprint a limited number of the Bulletins issued by the Station from 1895 to 1903. Bound volumes of these have been distributed to all the plantation managers of this Association. It is also the purpose of the Entomological Division to shortly publish a revised addition (in one volume) of all Messrs. Koebele and Perkins' earlier bulletins on entomological matters.

All experimental work now undertaken at the Station is of much wider range than hitherto, and in order that the sugar industry of Hawaii shall receive the greatest benefit from these experiments, your Committee decided to give the Station publications a much wider circulation among skilled employees of plantations than had been done in the past. An examination of the mailing list at the Station, made by your Committee, revealed the fact that the published Bulletins of the Station were being circulated in very limited numbers among the employees of the plantations, in almost every instance the managers alone receiving the same. A circular letter was addressed to the different agencies, setting forth this condition, and suggesting the submission of additional names of employees of the plantations to whom the Bulletins would be of interest and value. The response to this suggestion was general, with the result that the mailing list of the Station has been largely increased and the valuable information compiled in the Station's Bulletins is now placed in the hands of a large proportion of the skilled employees. The increased knowledge of methods and conditions thus obtained by those directly in charge of the practical operations of the plantations will, we are sure, awaken new interest in their work, with valuable results to all concerned.

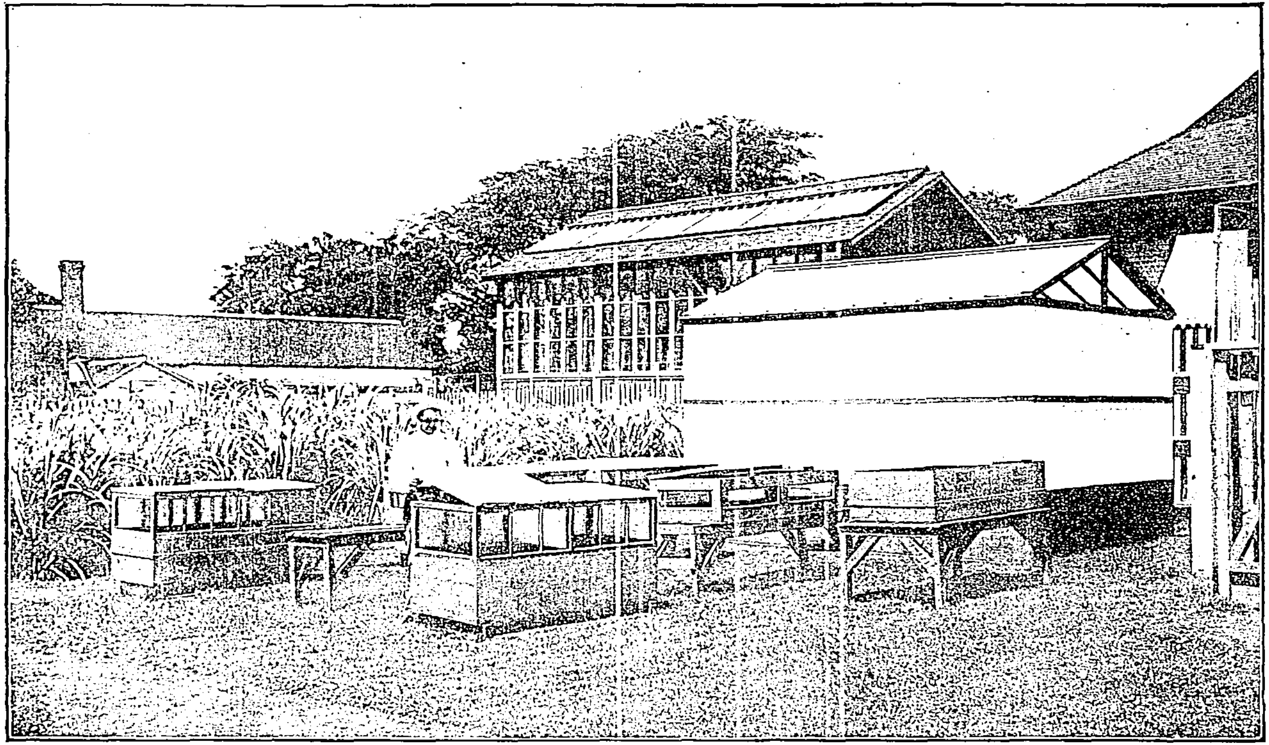
DIVISION OF AGRICULTURE AND CHEMISTRY.

LABORATORY WORK.

The increase in the number of determinations in the laboratories, which has been so marked for the past few years, is again in evidence, the total number of completed analyses being 1478 as against 1317 the previous year, an increase of 161. This is gratifying, as it shows that the members of the Association are realizing more and more the value of this

DIVISION OF AGRICULTURE AND CHEMISTRY.

1 Chemical Laboratory
2 Main road of experiment field
4 Moir's White cane
5 Irrigation of young seedling plant-cane



DIVISION OF AGRICULTURE AND CHEMISTRY

Houses and boxes used in growing cane from seed.

Division, and are availing themselves of its use as a means of increasing their knowledge of local conditions as to soils and consequent fertilizer requirements, thus enabling them to proceed intelligently toward the accomplishment of given desirable results.

Canes from Seeds.

The value of this Division has been most effectively demonstrated during the past year by the remarkably successful experiments of propagating canes from seed. The rapid growth of the seedlings has been a source of surprise to all. The propagation of new varieties of canes which are resistant to disease and at the same time good sugar producers, is of paramount importance, as we are all beginning to fully realize with our increasing knowledge of the presence here of serious cane diseases.

Sub-Stations.

The establishment of sub-stations in the different districts, both for agricultural experiments and the testing of varieties of cane, has been successfully inaugurated, and should be of great value to the plantation managers, owing to the fact that the experiments are being conducted under conditions as to soil and climate identical with those under which they are working. Every effort should be made to carry out fully and accurately these experiments by those under whose charge they are placed, and your Committee urges upon the managers of the different districts, where the sub-stations are located, to avail themselves of the opportunity of keeping in close touch with the experiments during the period of their progress.

Bulletins and Circulars.

The Bulletins issued by this Division during the year are as follows; they will be found as inserts in this "Yearbook:"

Bulletin No. 12. Comparative Analyses of Varieties of Cane. 20 pp.

Bulletin No. 13. Field Experiments with Sugar Cane. 17 pp. 3 plates.

Bulletin No. 14. Irrigation Experiments of 1905. 17 pp. 1 plate.

Bulletin No. 15. Fertilizer Experiments 1897-1905. 57 pp. 10 plates.

Further details of the work accomplished by this Division are ably and fully set forth by the report of the Director in Appendix I, page 15).

DIVISION OF ENTOMOLOGY.

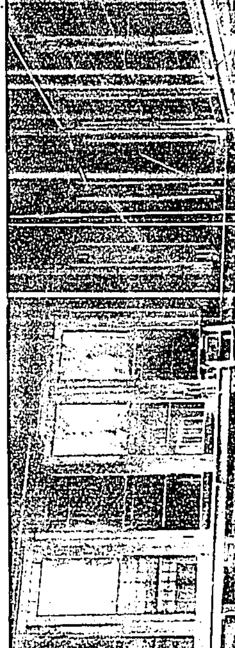
Cane Leaf-Hopper Work and Its Results.

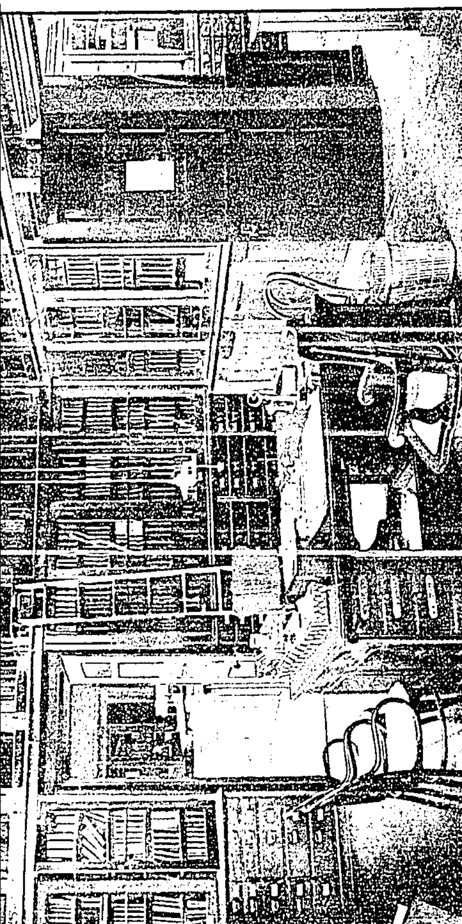
During the period the efforts of this Division have been confined practically to work connected with cane leaf-hopper, including the introduction, breeding and distributing of beneficial insect enemies to prey upon this serious pest. Few, if any, of us have forgotten the conditions of a year or two ago when the attacks of cane leaf-hopper were menacing our cane fields and when many of our plantations were face to face with a problem the outcome of which it was difficult to foretell. It will suffice to say that at no time in the history of the sugar industry of these Islands had such a large proportion of our crops been placed in the position of being practically abandoned as they then were and all because of the depredations of this insect pest and of the fungus diseases following in its wake. Simple reference to this condition is all that is necessary for your Committee to make so that attention may be called to the difference between then and now. When the last Annual Report of the Committee was printed a year ago, all were living in the hope that the promises held out by the entomologists of this Division would be successful. The result of the mission of Messrs. Koebele and Perkins to Australia in search of insect enemies to the hopper was still a matter of mere conjecture, inasmuch as the breeding of the one or two consignments of insects received up to that time was still in the experimental stage. The final success, however, of the introduction, breeding and distribution of these insects and their establishment on all our plantations is now no longer a matter of conjecture. The Director in his Report (See Appendix II) details the work of these beneficial insects and reports in part the results so far attained in diminishing the attack of leaf-hopper pest.

The Director in his Report also gives details regarding the success attending the various parasites bred out by him and his staff. It is needless for your Committee to dilate on the result so far attained by this Division in its work on cane leaf-hopper—the result is well known by most of our managers and it is the opinion of your Committee that unless something unforeseen occurs another year will show still more marked result in the diminution of the hopper pest.

Bulletins and Circulars.

The Director has in addition to the laboratory work of his Division given much time and labor to the publication of a number of parts of a Bulletin dealing with the cane leaf-hop-





ENTOMOLOGICAL DIVISION
Library

ENTOMOLOGICAL DIVISION
Laboratory

per and its insect enemies. In seeking enemies for the leaf-hopper of the sugar cane, Mr. Koebele in America, Australia and Fiji, and Mr. Perkins on these Islands, as well as in Australia, both used every effort to make themselves acquainted with such natural enemies of leaf-hopper as might be of service against this pest. In the course of their work, not only the actual cane hopper but scores of other leaf-hoppers, as well as scores of enemies of these, parasitic and predaceous, were carefully examined and collected. It is more than probable that no study so complete of the subject has ever been even attempted before and naturally much information of value at the present time and perhaps still more of the greatest potential value for future economic work, was acquired not without very much hard labor. Mr. Perkins, the Director of the Division, therefore considered it most expedient that the results of his labor and also those of Mr. Koebele be fully worked out without delay, for it is safe to say that if laid aside until some new and important work demanded attention, it would never be completed hereafter, but, like those most interesting results of the work in checking lantana, might, perhaps, never have been reported on, nor the scientific results (of such importance to the working entomologist) published. The parts of the Bulletin already published have been referred to under another heading in this Report as well as in the Report of the Director of the Division. For the most part, all of those parts consist of technical descriptions of the insects studied (most of them being new to science) and which necessarily had to be completed, with perhaps one or two others later on, before the preface to the whole could be written. One could not write intelligently of things that were nameless, nor could statistics be drawn up till by the completion of the parts referred to, the "figures" had been obtained. The last written part of the Bulletin, therefore, which has yet to be published (the preface) will obviously be of most interest to all members of the Association, the others rather to those many experiment and agricultural stations that send us freely copies of their own scientific work, but most of all to the entomologists of our own Station while still continuing leaf-hopper work, or in the event of their having to take it up again on some future occasion. For all these reasons, it has been very advisable that these scientific Bulletins be illustrated by "figures" and that these should be of the best production. Better none at all than inaccurate and poorly executed drawings.

The following are the parts of Bulletin No. I which have been issued by this Division during the period. These will be found included as inserts in the "Yearbook":

Bulletin No. I entitled "Leaf Hoppers and Their Natural Enemies."

Part No. 1.	Dryinidae	69 pp.	
2.	Epipyropidae	17 pp.	1 plate.
3.	Stylopidae	21 pp.	4 plates.
4.	Pipunculidae	34 pp.	3 plates.
5.	Forficulidae	20 pp.	3 plates.
6.	Mymaridae	20 pp.	3 plates.

Staff Appointments, Etc.

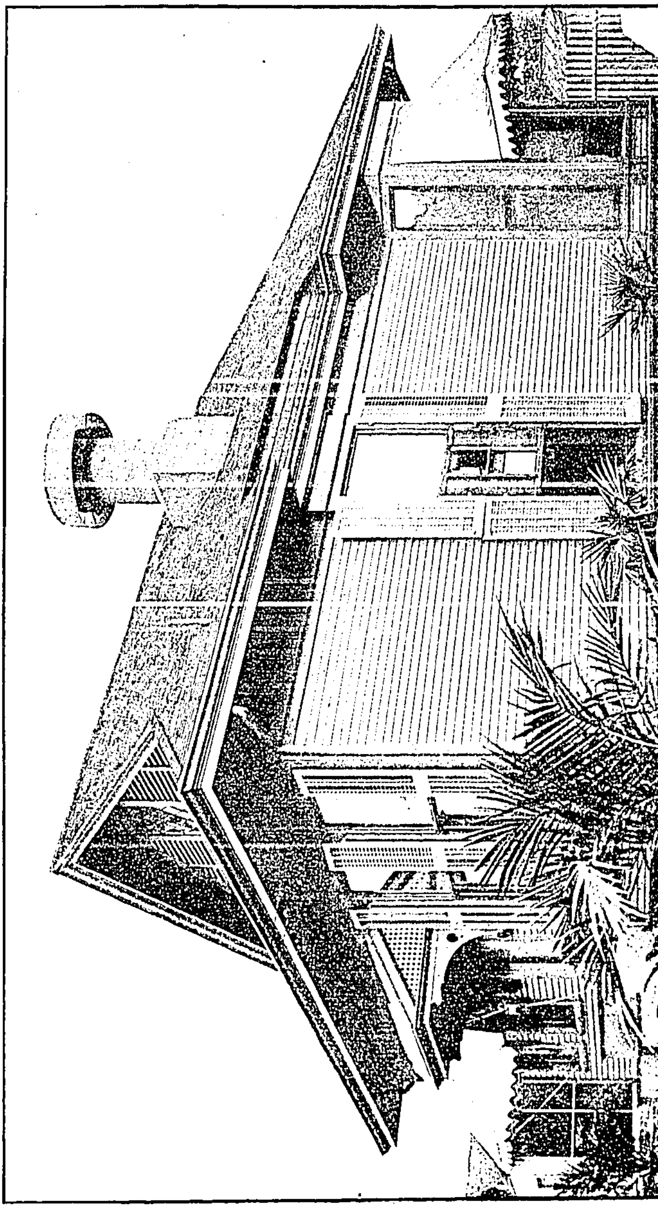
Since the last Annual Report was presented this Division has had added to its staff one more entomologist, viz.: Mr. F. Muir, late of Mozambique, East Africa. Mr. Muir is a young man who has had much experience in field work in Africa, and comes here highly recommended. He has been detailed by the Director to continue the work initiated by Mr. Koebele in connection with securing beneficial insects in foreign countries, and with this object left for Fiji a week or two ago. Mr. Koebele, after a long and trying service in the field in Mexico, Australia and Fiji, was granted a vacation so that he might, if possible, recuperate in health, and perhaps later on continue to be of service to the Division in the line of entomological work for which he is so aptly fitted. The Trustees have acted similarly with Mr. Perkins, the Director of this Division, having granted that gentleman a leave of absence which he will avail himself of next spring after he is through with the trying work he has had before him in connection with leaf-hopper.

Full details regarding the work of this Division and of its staff are given in the Director's Report (See Appendix II, page 29).

DIVISION OF PATHOLOGY AND PHYSIOLOGY.

Organization and Staff.

As indicated in the last Annual Report, the Division of Pathology and Physiology had its beginning in various suggestions as to the losses suspected to be due to the ravages of fungi among our cane crops. For some months the Committee conducted a correspondence with prominent authorities in various parts of the world with the object of securing a pathologist to take charge of the proposed new Division. This resulted in the spring of the present year in the engagement of Dr. N. A. Cobb, B. Sc., Ph. D., (late pathologist for the Department of Agriculture, N. S. W.), as Director of the Division. Dr. Cobb took up his duties in March, and since that time the organization of the Division and to a considerable extent also investigation of our cane diseases have gone regularly forward. From this statement it will be seen that the Division of Pathology and



DIVISION OF PATHOLOGY AND PHYSIOLOGY
Main Laboratory

Physiology began its existence about eight months ago. At that time there were no buildings and there was no equipment, and but a single officer. Soon afterwards an Assistant Director was engaged in the person of Mr. L. Lewton-Brain, B.A., F.L.S., (late Mycologist and Lecturer in Agriculture of the Imperial Department of Agriculture for the West Indies). Mr. Lewton-Brain began his duties about the middle of August. About the first of July, Mr. E. M. Grosse (late Artist and Assistant to the Pathological Department of Agriculture of N. S. W.) began his work as an assistant in the Division. During the latter part of June, Mr. E. W. Chambers (late Artist and Engraver of the Department of Agriculture, N. S. W.) was engaged as illustrator (in part) to the Division. The time during which the Division has been in existence is so short that this first Annual Report of its activities has comparatively little to chronicle. The work of securing assistants and that of buying and fitting up apparatus, and the planning and erecting of a building to house the Division, as well as the purchase of a plot of land suitable for the field experiment work that will be so necessary a part of the divisional work, have absorbed most of the time. From the very first, however, samples of cane were received from the various plantations and these were examined and reported on as well as the then incomplete facilities of the Station would permit. As time went on it was possible to increase the thoroughness of this part of the work, but it is only during the last few weeks that the officers of the Division have felt that this main part of their work could receive anything like justice, and even at the present moment considerable remains to be done before all the necessary apparatus will be in good working order. However, this difficult period will before long be a thing of the past. (It perhaps ought to be explained that it was absolutely necessary for the Director to be absent from Hawaii during the months of May and June, and that during that time the activities at the Station partially ceased).

Buildings and Construction.

The buildings of the Division are located together with those of the Division of Agriculture and Chemistry, and Entomology, on the block of land bordered by Keeaumoku and Makiki Streets and Wilder Avenue, and on the corner of Bingham and Alexander Streets. The general appearance of the main building will be gathered from the half-tone engraving herewith, the peculiar looking structures on the roof being ventilators connected with all the rooms below, but more particularly that designed for culture work. Internally the building is divided into five rooms:

1. A large general room to be used as a library, museum and meeting-room, as well as work room for various miscellaneous classes of work.

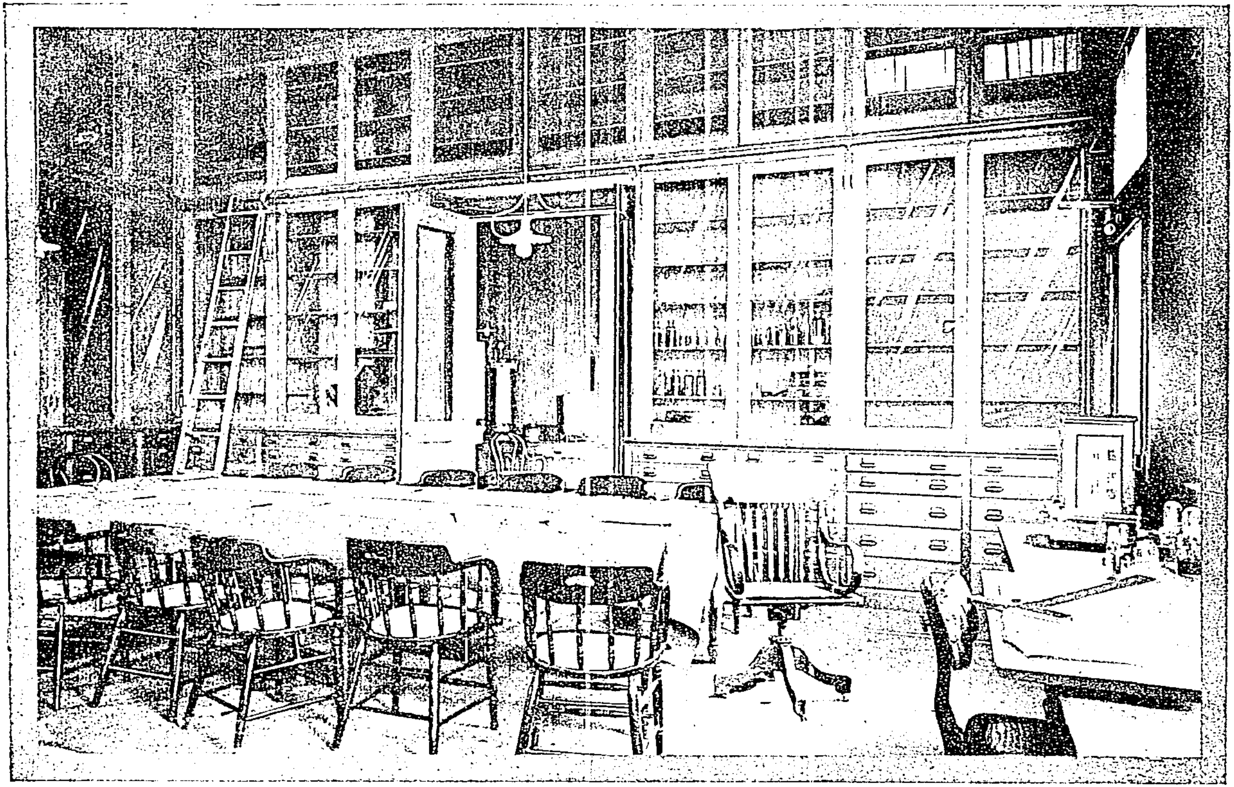
2. A culture-room, fitted with various instruments used in the cultivation of micro-organisms.
3. A microscope-room, more especially adapted to the examination, photographing and drawing of such objects as require special care.
4. Illustration room, fitted with drawing and photographic apparatus, and having attached—
5. A photographic dark room.

The main building of this Division, like that of the other Divisions of the Experiment Station, is a wooden structure, and there is no special provision for the preservation of objects of special value in case of fire. The main reliance is on the municipal Fire Department, of which there is a well organized branch about an eighth of a mile distant. The building is raised about two feet off the ground and rests on eighty-one bearings, to ensure steadiness. The floors are of double thickness, specially constructed, and with tarred paper between the two layers. The latter is a provision against dampness, required for the preservation of herbaria and other material of that sort. The walls of the building are everywhere lined with tarred paper as an additional precaution against dampness and to insure freedom from dust as required during inoculation work. The rooms are all arranged so as to be readily darkened when necessary, as for instance when projections are required. In an adjacent building is a well equipped shop for the construction and repair of apparatus that is constantly required in connection with investigation work. Later on, it is thought that some room may be provided where larger objects may be photographed than can be handled in the present quarters, such as large stools of cane, etc.

A second small building of the Division of Pathology and Physiology is located at the special experiment field of the Division, a block of land measuring about three-fourths of an acre at the corner of Alexander and Bingham Streets. This building, formerly a stable and servants' quarters, contains two small rooms, one of which it is proposed to fit up as an examination room for such work as cannot be carried to the main laboratory on account of the time that would elapse, or on account of the possible danger that might accrue to the crops of the Division of Agriculture and Chemistry. In addition, there is a wagon house and two horse-stalls. It is thought that these can be altered in time to meet the needs of the experiment work carried on at the experiment field.

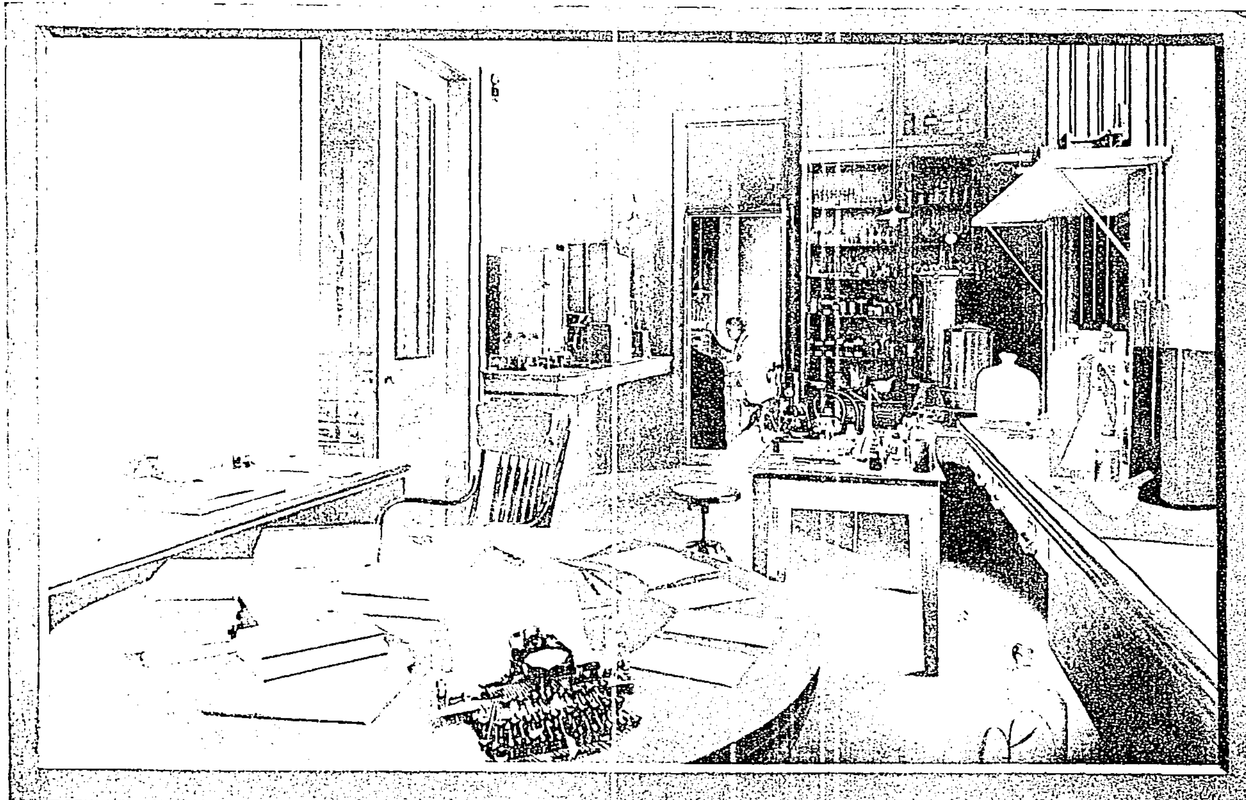
Programme of Future Work.

One of the first things to which the Director turned his attention was a survey of the field of work open to the Division. This



DIVISION OF PATHOLOGY AND PHYSIOLOGY

Combined Work-Room, Library, Museum and Meeting-Room, Main Laboratory



DIVISION OF PATHOLOGY AND PHYSIOLOGY

Culture-Room, Main Laboratory

resulted in the preparation of a program having special reference to the local needs so far as he could then foresee. This program is as follows: What seem the most important items are placed first. Needless to say, the Division will always welcome additions to this list, as well as suggestions as to the order in which the work should be taken up.

PROGRAMME.

FOR MORE IMMEDIATE CONSIDERATION.

1. Root-disease of Cane. Culture of. Soil treatment for root diseases; sunning, liming, drainage, burning.
2. Colored illustrations of diseased cane.
3. Raise seedling-canes and test same as to immunity.
4. Immunity tests at Plantations, as well as at Experiment Station.
5. Bulletin on testing varieties as to resistance.
6. Pure culture work on all the cane fungi to ascertain all possible spore-forms.
7. What strength of Bordeaux will cane stand?
8. Liming cane.
9. Use of molasses in fungicides.
10. Fungus fauna of Hawaiian cane.
11. Catalogue of cane diseases of fungus and microbe origin.
12. Summarizing the cane disease literature of other countries.
13. Comparative anatomy of a resistant variety, e. g. Yellow Caledonia.

PHYSIOLOGICAL and ANATOMICAL (Mostly).

14. Anatomy of a seedling cane.
15. Structure of the healthy cane-root.
16. Structure of the cane-seed.
17. Structure of the cane "eye."
18. The fibre in health and disease.
19. Bulletin on gumming.
20. Introduction of new varieties.
21. Production of hybrids.
22. Why are some canes infertile?
23. Inoculation experiments with bacterial diseases.
24. Inoculation experiments—experiment with species of Cercospora.
25. To what extent, if at all, is the Trichosphaeria independent of wounds.
26. Rotation of crops
27. Water-cultures and drawings of all sorts of spores, (cane-fungi) and their mycelium.
28. Yeasts as a cause of cane disease, or as connected with disease.
29. Nematode diseases of cane, e. g. Heterodera javanica.
30. Spraying experiments with spores of T. sacchari on young cane, etc.
31. Try sawing cuttings, and other methods of preparing same.
32. Origin of the internal nourishment of the sprouting cane bud.
33. What is the chemical, physical, biological, cause of the red color in the tissues of diseased cane?
34. What is the actual length of the destructive portion of the life history of T. sacchari, and other species?
35. Can plants be made to absorb fungicides, and if so, with what effect?

FUNGI DESERVING ATTENTION:

1. HYPOCREA sacchari.
2. THIELAVIOPSIS ethaceticus.

3. COLLETOTRICHUM falcatum, Went.
4. CERCOSPORA kopkei, sacchari, vaginae.
5. DEMATIUM.
6. LEPTOSPHAERIA sacchari.
7. SCHYZOPHYLLUM disease.
8. ERIOSPHAERIA sacchari.
9. MARASMIUS sacchari.
10. USTILAGO sacchari.
11. UREDO kuhnii.
12. UROCYSTIS.
13. PENICILLIUM.
14. CLADOSPORIUM herbarum, javanicum.
15. MUCOR.
16. PESTALOZZIA fuscescens.
17. ALLANTOSPORA radicicola.
18. UROMYCES.

It will be seen that the list of work to be undertaken is a formidable one. After a careful consideration of the matter, the Director is confident that the money spent in support of the Division will be amply returned as the result of its investigations, at least for some time to come. He finds that the losses suspected to be due to the attacks of fungus diseases have not been overestimated, and says that unless greater attention is paid to this feature of the cane crops than has been paid to it in the past, future losses will be greater than at present.

BULLETINS AND CIRCULARS.

The following Bulletins and Reports have been issued by the Division, which will be found as inserts in this "Yearbook:"

Bulletin No. 1. The Inspection and Disinfection of Cane Cuttings. 40 pp. eight plates.

Bulletin 2. Preliminary Notes on Root disease of Sugar Cane in Hawaii. 40 pp. with twelve illustrations in the text.

Bulletin 3. The Gumming of the Sugar Cane. 40 pp. with twelve illustrations in the text and two colored plates.

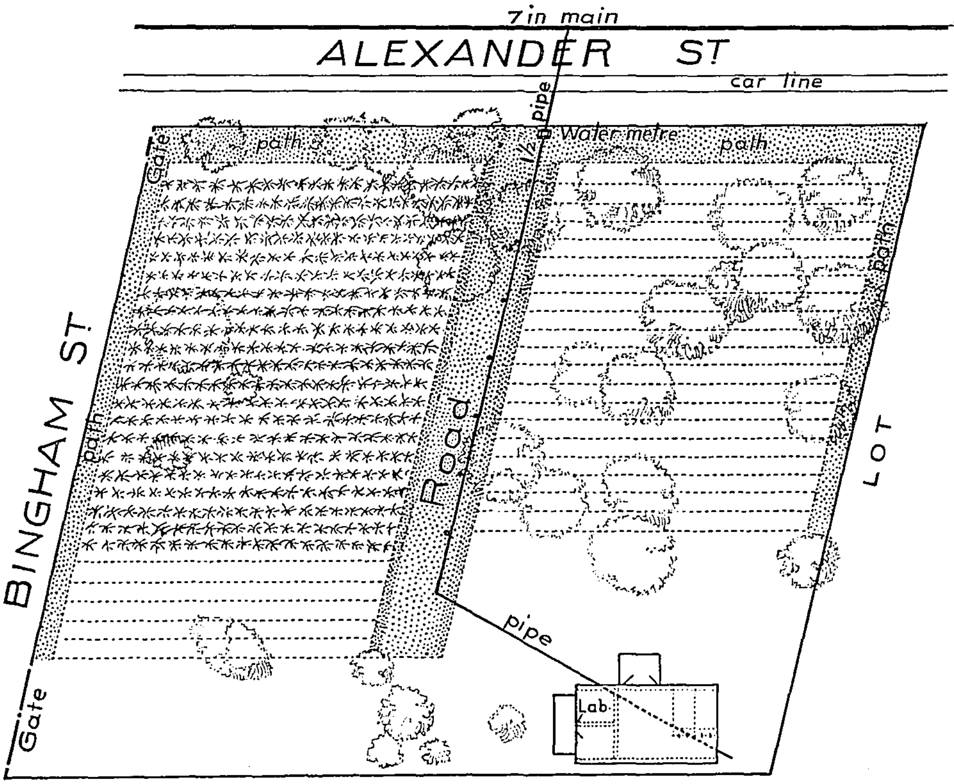
These Bulletins and Reports cover about one hundred and fifty pages and are illustrated by nearly fifty original illustrations. An effort has been made to utilize as promptly as possible what special information the various officers possessed through their experiences in other countries that would be of use to the cane growers of Hawaii. This plan will be pursued in future. In addition there will be the special studies entailed in connection with the program already outlined.

In the course of the investigations conducted by the officers of the Division about twenty new species of organisms have been discovered, and very complete technical descriptions of the same have been placed on file and have been placed before the parties most interested from an economical point of view. In the course of time the descriptions of these species will be published.

DIVISION OF PATHOLOGY AND PHYSIOLOGY

Portion of the Experiment Field.

Plan of the Experiment Field of the Division of Pathology and Physiology, drawn to scale. The trees have been drawn to scale to show the original condition of the field as nearly as possible. The right hand half of the field carried a heavier growth of trees than the other half, and moreover horses were formerly in the habit of camping under the trees of this part of the original field, as the trees there afforded better shade in the daytime. These facts rendered



this part of the field less suitable for experiments. Accordingly the first year's planting has been confined to the other and less objectionable portion. This course leaves the experiments as little as possible under the uneven influence of these former factors, and gives the best conditions possible under the circumstances. Land newly cleared and newly cultivated nearly always presents these unevenesses, and on that account, unless fallowed for a sufficient length of time, is more unsuited for many classes of experiment work.

The plan is lettered and fully explains itself.

EXPERIMENT FIELD.

The experiment field (illlstrated herewith) is located at the corner of Alexander and Bingham Streets. The soil was carefully examined by the Director of the Agricultural and Chemical Division previous to its purchase. The results of the examination were as follows:

	Agricultural Method			Aspartic Acid Method		
	High Ground	Low Ground	Sub-soil	High Ground	Low Ground	Sub-soil
Lime	2.245	2.025	1,855	.3540	.3414	.3458
Potash	2.383	1.070	.575	.0300	.0486	.0254
Phos. Acid	.963	.793	.800	.0484	.0388	.0431
Nitrogen	.190	.211	.134	.1900	.211	.1340
Moisture	12.800	13.34	12.38	12.80	13.34	12.380
Vol. Matter	10.530	10.35	9.08			
Fine Earth	61.00	63.50	38.00			
Coarse Earth	39.00	36.50	62.00			
Coarse Earth (Washed)	31.50	34.00	30.50			
Absorptive Power	31.50	34.00	30.50			
Reaction	Neutral	Neutral	Neutral			

From this it will be seen that the land is in every way suitable for the work from the agricultural point of view, being land well adapted to the growth of cane. A new main has been laid along Alexander Street, from which the plot may be irrigated through the one and one-half inch pipe connecting directly with the main. The pressure on this main is found to be very regular so that irrigation water can be applied through the agency of a meter with a maximum of convenience.

APPARATUS AND METHODS FOR ITS USE.

The Director's Report (see Appendix III, page 39) will give full details regarding all apparatus with which this Division has been supplied and the uses to which the same can be put for future operations.

In concluding its Report for the fiscal period, your Committee urges upon all members of this Association to avail themselves of opportunities frequently to visit the Station, and to keep in close touch with the work being done, and with the scientific men in charge, whose study and solution of the serious problems in connection with our great industry are such important factors in its successful continuance.

Respectfully submitted,

W. M. GIFFARD,
Chairman.

E. D. TENNEY,
G. M. ROLPH,
Experiment Station Committee

Honolulu, October 28th, 1905.

(APPENDIX I.)

REPORT OF THE DIVISION OF AGRICULTURE AND CHEMISTRY.

To the Experiment Station Committee of the Hawaiian Sugar Planters' Association, Honolulu, T. H.

Gentlemen:—Herewith I beg to submit a report on work of the Division of Agriculture and Chemistry of the Experiment Station for the year ending September 30th, 1905:

LABORATORY WORK.

General Analytical Work. The total number of analyses completed in the laboratories number 1478, the work of the chemical staff being summarized as follows:

Fertilizers, complete	388
Nitrate of soda	37
Sulphate of Ammonia	2
Dried blood	1
Fish scrap	11
Bone meal	4
Tankage	11
Sulphate of potash	1
Double superphosphate	1
Fertilizers, redeterminations	108
Soils, Aspartic Acid Method	99
" Agric. Method, complete	32
" Agric. Method, partial	120
" Mechanical analysis, complete	18
" Mechanical analysis, partial	134
Sugars, polarization	117
" moisture	53
Sugar solutions, polarization	160
" ash complete	2
" ash sulphated	33
" bacteriological	1
Bagasse, complete	2
Molasses	7
Cane juices	29
" fibers	2
" complete	3
" ashes	8
Mud press cake	1
Mud press cake bacteriological	2
Mesquite beans	1
Algaroba beans	2
Furnace ashes	10

Lime	4
Phosphate rock	1
Water	1
Water drainage	72
Total	1478

Fertilizer Analyses—

Samples received from Plantations:

Complete fertilizers	388
Nitrate of soda	37
Sulphate of ammonia	1
Dried blood	1
Fish scrap	11
Bone meal	4
Tankage	11
Total	453
Samples received without guarantee	79
Samples received below guarantee	69
Rebate on 69 fertilizers below guarantee	$4,652.15
Rebate on total fertilizers, calculated	5,635.00

During the past year 453 samples of fertilizer have been submitted to the laboratories of this Division for analysis, representing a gain of 120 samples over the number received during the twelve months ending September 30th, 1904. While the conformity between Experiment Station findings and manufacturers' guarantees was not as close as that shown in the last report, the results of this control work continue to be very satisfactory. The value of these examinations is fully shown by the following figures:

Fertilizer samples received:

1900	75
1901	189
1902	229
1903	368
1904	333
1905	453

Difference between valuation of Manufacturer and Experiment Station:

1900	$12,000
1901	11,000
1902	9,000
1903	4,900
1904	3,089
1905	5,635

Average rebate per fertilizer as shown by analysis of samples:

1900	$160.00
1901	58.20
1902	39.30
1903	13.32
1904	9.28
1905	12.44

WEEKLY MILL REPORTS.

On November 21st, 1904, a meeting of a joint committee representing the Hawaiian Sugar Planters' Association and the Hawaiian Sugar Chemists' Association was held, at which the following resolution was passed:

"This committee recommends to the Trustees of the Hawaiian Sugar Planters' Association that the weekly averages on the report forms adopted by the Hawaiian Sugar Chemists' Association be sent to a central bureau, there to be collated and brought into tabular form for distribution to the various plantations in the exchange."

The following action was taken by the Trustees of the H. S. P. A. in regard thereto:

"That the committee's report be adopted and that the secretary be instructed to communicate with the managers of the several plantations having chemists requesting them to send to their agents for the purpose of transmittal to the Director of the Experiment Station of the Hawaiian Sugar Planters' Association the weekly reports of the results of the chemists' work, and that a copy of the report of the committee be sent to each manager."

In pursuance with the action taken by the Hawaiian Sugar Planters' Association, the following mills and plantations submitted to the Division of Agriculture and Chemistry their weekly reports bearing on the manufacture of sugar:

Waianae Company,
Kahuku Plantation Company,
Ewa Plantation Company,
Honokaa Sugar Company,
Hawaiian Commercial & Sugar Company,
Waialua Agricultural Company,
McBryde Sugar Company,
Lihue Plantation Company,
    Hanamaulu Mill.
    Lihue Mill,
Kohala Sugar Company,
Maui Agricultural Company,
    Paia Mill,
    Haiku Mill,

Kekaha Sugar Company,
Koloa Sugar Company,
Hilo Sugar Company,
Paauhau Sugar Plantation Company,
Oahu Sugar Company,
Onomea Sugar Company,
Olaa Sugar Company,
Hakalau Plantation Company.

The first tabulated statement was issued on January 12th, 1905, and up to the close of the year ending September 30th, 1905, 38 statements were sent to the mills in the exchange. In the compiling of these statements, the Director of the Division was assisted by Messrs. Peck, Werthmueller and Jordan.

FIELD WORK.

Distribution of Varieties of Cane. In order that the many new varieties of cane growing at the Station might be tried under the different soil and climatic conditions of the islands, approximately nine tons of cuttings were shipped to the various plantations. The canes were divided as follows:

Varieties.	Boxes.
Barbados No. 5	8
" " 8A	8
" " 147	10
" " 156	23
" " 176	10
" " 208	10
" " 244	8
" " 306	8
Big Ribbon	2
Cavengerie	4
Demerara No. 74	11
" " 95	3
" " 115	17
" " 116	26
" " 117	41
" " 145	9
" " 1135	27
" " 1483	1
" " 1937	3
Gee Gow	5
La. Striped	3
La. Purple	3
White Mexican	22
Striped Mexican	5
Mexican Bamboo	1

Moir's White	22
Striped Singapore	5
Tiboo Merd	5
Yellow Caledonia	2
White Bamboo	32
Yellow Bamboo	2
Queensland No. 1	11
Queensland No. 4	4
Queensland No. 7	13
Queensland No. 8A	2
Manulele	1
Rappoe	1
Total	368

Very favorable reports concerning a number of these canes have been received from plantations, and there is little question but what some of them will soon be grown on a large scale in several island districts.

New Varieties Received. On April 5th, 1905, ten new varieties of cane were received from Fiji in care of Prof. A. Koebele, who had obtained the same from Mr. James Clark of Rarawai Mill. These canes were labelled as follows:

Badila,
Couve No. 27,
Malagache,
Hybrid Footiogoo,
Innis 131,
White Tanna,
Goru,
Hitam,
Bonbari,
Petit Senneville.

On their arrival in Honolulu, these varieties were carefully disinfected by Mr. Alcander Craw and examined by Messrs. Craw, Koebele and Perkins, and by Dr. Cobb, in order that no insect and fungus pests might be introduced into this country from Fiji. After passing through the hands of the plant pathologist and entomologists, the cuttings were planted in the special insect-proof cane propagation house of the station in order that seed cane might be obtained for propagating the varieties in the field. Unfortunately, of these canes, only four germinated, viz:

(1) Couve 27,
(2) Badila,
(3) Hybrid Footiogoo,
(4) Innis 131.

These varieties will be added to the list of those undergoing trial in the Experiment Station field and as soon as sufficient cuttings are available for plat experiments, will be brought into competition with the older canes.

Propagation of Seedling Canes. During the past year this Division has devoted considerable attention to the growing of canes from seed with the hope of ultimately securing, through careful selection, new and improved varieties.

During this first season's work no young canes were produced from island grown seed (only one seed, and that from Demerara No. 74, sent by Mr. H. A. Baldwin, having germinated,) although a large degree of success was obtained with seed introduced from Barbados, Jamaica and Trinidad. The non-germination of seed from our Hawaiian varieties, so-called, is in no way discouraging, and may be ascribed in large measure to the unfavorable weather conditions which prevailed during the tasselling period of last year when high winds and rainy weather destroyed large numbers of the tassels at the station before they were developed sufficiently to permit the proper fulfillment of their reproductive functions. Then again, the long period during which the Lahaina, Rose Bamboo, and Yellow Caledonia canes have been propagated from cuttings has decreased to a very considerable extent the fertility of their seed. A quantity of cane tassels from standard and also from newly introduced varieties were received from a number of plantation managers who observed considerable care in their selection, but the results in these cases were likewise negative.

Through the kindness of the U. S. Department of Agriculture and the Imperial Department of Agriculture for the West Indies, three small consignments of pulverized cane tassels were received from Barbados, Jamaica and Trinidad. Considering the long time that these seeds were in transit before reaching these Islands, the results exceeded our expectations, and may be briefly summarized as follows:

Parent Cane.	Sown	First Germinated	Last Germinated	Total Germinated	Planted in Field
B. 3718	Dec. 21st	Dec. 27th	Jan. 12th	74	10
B. 4282	Dec. 21st	Dec. 27th	Jan. 20th	134	11
Bourbon	Feb. 4th	Feb. 14th	Feb. 15th	6	2
B. 306	Feb. 4th	Feb. 10th	Feb. 15th	22	10
D. 115	Feb. 4th	Feb. 10th	Feb. 10th	98	57
D. 99	Feb. 4th	Feb. 10th	Feb. 16th	35	22
T. 223	Feb. 18th	Feb. 24th	Mar. 5th	287	88
T. 230	Feb. 18th	Feb. 24th	Mar. 4th	156	79

The protracted spell of unusually cold weather which prevailed during the whole of last winter exerted a very retarding influence on the growth of these young cane plants, and those of the seedlings, planted in December, which survived were kept alive with difficulty until the advent of warmer weather. This accounts for the small percentage of the total number which germinated that reached a sufficient size for planting in the field. The canes which had a later start, and therefore escaped a considerable period of the cold spell, died off to a very much smaller extent, as is shown by the following figures:

Planted	Total Germinated	Planted in Field	Per Cent. Planted in Field.
Dec. 21st, 1904	208	21	10
Feb. 4th, 1905	161	91	56
Feb. 18th, 1905	443	167	38
	812	279	34

All of the 279 canes which were planted in the Experiment Station field are living, the first of the lot having been set out on the 3rd of May, 1905, and the last on July 18th, 1905. On August 29th, 1905, 46 of these young cane plants had made such a vigorous growth, with the formation of stalks of good diameter and large internodes, that they were re-planted from cuttings. On the 13th of September, 1905, 47 more were treated in the same way. The remainder of canes, from seed, which were planted in the field will be allowed to flower during the present fall, when it is expected that a considerable quantity of fertile seed will be obtained for future work along these lines.

In view of the fact that it has long been held that cane seed could not be imported from long distances and retain its fertility, the results obtained by this Division during the past season are of particular value from a scientific point of view. After being one month in transit and travelling a distance of practically six thousand miles, these seeds produced plants which showed under our Hawaiian conditions a greater hardihood than young seedlings evidently display in Demerara. It may be of interest at this place to quote from the "Report on the Agricultural Work in the Botanic Gardens, (British Guiana) during 1893, 1894 and 1895."

"Little difficulty is now experienced in germinating canes from seed, and. as a rule, several thousand seeds germinate each year. But here the easily successful part of the work ends, as owing to climatic conditions and attacks of insect and other pests sixty per cent. of the plantlets die before reaching sufficient maturity to be picked off into baskets and of these over fifty per cent. perish from various causes beyond our power of control. During the four seasons, 1892 to 1895, we have germinated 17,000 seeds of varieties of canes other than the Brekeret and Karaka-rawa (seedlings of which kinds having been proved to be valueless as sugar producers, are now only raised for use as speciments,) of which 7,070 survived to be picked off into baskets, whilst 3,293 of these lived to the stage at which they could be planted in the ground." (Sugar Cane, Vol. XXIX pg. 354.)

It is thus seen that while in Hawaii 34 per cent. of the young plants reached a sufficient size for planting in the field, in Demerara only 19 per cent. were set out into the ground during the seasons mentioned. During the 1894 season in Demerara, only 3½ per cent. of the plantlets survived to the planting-out stage.

Bearing on the difficulty of obtaining fertile seed during certain seasons, a second extract from the British Guiana Report may be quoted, showing, as it does, that no discouragement need be entertained over the non-germination of seed from our so-called Hawaiian canes during the past season.

"Season of 1893. Owing to the replanting of the old varieties of cane, only the Bourbon, the red ribbon and the purple and white transparent kinds were available among them as sources of cane arrows for sowing. Eighteen boxes of Bourbon (our Lahaina, C. F. E.) were sown and 5 seeds germinated, all of which damped off in their early infancy. Forty-three boxes of the other varieties, seedlings from which we are anxious to obtain, were sown at intervals from October 25th to November 28th, but not a single seed germinated. If we had to depend only on the seeds of these various old varieties, the work of this season would have proved as unfruitful as did that of 1891."

While I regret that no seedlings were produced from the seeds of our Lahaina, Rose Bamboo and Yellow Caledonia varieties during the past season, I consider that the possibilities of obtaining good canes from imported seed are fully as great as in the case of canes obtained from the seed of recently introduced seedlings, such as D. 94, D. 75, D. 117, etc. The imported seed germinates, and the young plants make their growth and subsequently undergo a selection under Hawaiian conditions. Now that a start has been made with this kind of work, it will not be necessary in the future to obtain seed from foreign sources for pursuing it further. The many varieties of canes now growing at the Experiment Station should offer sufficient fertile seed for future requirements.

To avoid the very remote danger of introducing fungus diseases through the use of imported seed in these experiments, care was exercised to only send to such countries for material as were apparently free from diseases other than those already established in the Islands. Furthermore, very small quantities (a few handfulls) of the cane seed were received and these from responsible parties such as the U. S. Department of Agriculture and the Imperial Department of Agriculture for the West Indies. A small lot of cane seed arriving from Queensland a short time ago was disinfected before planting and the small particles of the arrow stems burned; from this lot no young canes were obtained. Owing to the small spark of fertility possessed by cane seed in general, it would hardly seem possible to treat it effectively with fugicides without completely destroying their germinating power.

Before concluding these remarks on the growing and propagation of seedling canes, I desire to express the appreciation of the Division for the co-operation extended by Mr. H. P. Baldwin, who, by sending to the Experiment Station a quantity of specially selected Olinda soil for use in the seed bed, contributed to the successful termination of this preliminary work. The thanks of the Division are also due Messrs. Robert Hall, Geo. F. Renton David Forbes, H. A. Baldwin, and E. E. Olding for consignments of cane tassels for use in this work.

Drawing of Canes. At the present time, a number of varieties are allowed to occupy space in our cane field notwithstanding the fact that they have, on past trials, shown themselves to possess no special merit. They are merely preserved in order to facilitate the identification of canes which the Division occasionally receives for classification. These varieties are now being drawn and put into colors by Mr. E. M. Grosse, artist of the H. S. P. A., thus making the area, which they at present occupy, available for new varieties. The accuracy and high class nature of Mr. Grosse's work leaves nothing to be desired in the way of perpetuating the external features of cane varieties in perfect detail.

Field Plats Harvested in 1905. In April of this year, a series of tests, bearing upon the question of fertilization, was harvested and the results published as a bulletin (No. 15) of this Division. As these experiments have occupied the attention of the Station during a period of eight years, the conclusions reached following a study of the data presented are of particular value.

Plat Experiments to be Harvested in 1906. These tests were described in some detail in the Annual Report to the Experiment Station Committee in 1904, and reference to the same may be had on pages 17 to 21 of the Committee's Report for that year.

Plat Experiments to be Harvested in 1907. These experiments are being conducted with Lahaina cane, planted in June, 1905, to allow a comparison of yields following different periods of harvesting plant cane, with short and long rattoons following the same. These may be described as follows:

Plat No. 1. Planted June, 1905; to be cut December, 1906.
Short ratoons to be cut April, 1908.
Plat No. 2. Planted June, 1905; to be cut January, 1907.
Short ratoons to be cut in April, 1908.
Plat No. 3. Planted June, 1905; to be cut February, 1907.
Short ratoons to be cut in April, 1908.
Plat No. 4. Planted June, 1905; to be cut in March, 1907.
Short ratoons to be cut in April, 1908.
Plat No. 5. Planted June, 1905; to be cut in April, 1907.
Short ratoons to be cut in April, 1908.
Plat No. 6. Planted June, 1905; to be cut in December, 1906
Long ratoons to be cut in April, 1909.
Plat No. 7. Planted June, 1905; to be cut in January, 1907.
Long ratoons to be cut in April, 1909.
Plat No. 8. Planted June, 1905; to be cut in February, 1907.
Long ratoons to be cut in April, 1909.
Plat No. 9. Planted June, 1905; to be cut in March, 1907.
Long ratoons to be cut in April, 1909.
Plat No. 10. Planted June, 1905; to be cut in April, 1907.
Long ratoons to be cut in April, 1909.

SUB-STATIONS.

The establishment of sub-stations on the various islands of the group in conformance with the policy recently formulated by the Trustees of the Hawaiian Sugar Planters' Association, has without doubt constituted one of the most important lines of work undertaken by the Division of Agriculture and Chemistry during the past year. In the starting of these plantation stations the Director has been ably assisted by Mr. E. G. Clarke, the Agriculturist of the Experiment Station, who has made frequent visits to the sub-stations and carefully followed the directions of the Division pertaining to their establishment.

It was deemed important that two classes of sub-stations be created: one to deal with varieties of cane and the other with agricultural experiments in general.

Variety Substations. Owing to the limited amount of seed cane of the several varieties on hand at the main station, it was found necessary to start nurseries on various plantations during the past planting season from which a good supply of cuttings could be obtained for the sub-stations in 1906. Enough seed cane will be produced in each of the cane nurseries to plant the middle two rows (the test rows) of each experiment plat, the additional rows being supplied with seed cane by the main station at the next planting period.

Cane nurseries have, in this manner, been started on the following plantations:

Hawaiian Agricultural Company,
Olaa Sugar Company,
Pacific Sugar Mill,
Kohala Sugar Company,
Hawaiian Commercial & Sugar Company,
Kipahulu Sugar Company,
Waialua Agricultural Company,
Hawaiian Sugar Company.

Substations dealing with Agricultural Experiment. All of the stations of this class, established during the past year, will deal with the very important subject of fertilization. Six of these have been successfully established as follows:

Hilo Sugar Company (1),
Paauhau Sugar Plantation Co. (1),
Kohala Sugar Company (2),
Hawaiian Commercial & Sugar Co. (1),
Ewa Plantation Company (1).

Two stations were given to the Kohala Sugar Company owing to its central location in the Kohala district, one sub-station to be irrigated and the other unirrigated. A station started on Grove Farm Plantation, Kauai, was given up by the management, owing to what were considered insufficient facilities for pursuing the work. On account of the near close of the planting season, it was not deemed advisable to establish another station on Kauai until next year.

A detailed description of the principles on which the sub-stations have been started together with diagrams (which were slightly modified in a few instances) are given in Bulletin No. 13, pp. 11 to 17, of this Division.

From time to time additional stations will be established on other plantations to cover different lines of work, and the results which will be derived from these careful investigations conducted under the various island conditions, will be of very considerable value to the sugar industry of this Territory.

BULLETINS OF THE DIVISION.

During the year ending September 30th, 1905, four bulletins have been issued by the Division of Agriculture and Chemistry, viz:

Bulletin No. 12. Comparative Analysis of Varieties of Cane.

Bulletin No. 13. Field Experiments with the Sugar Cane.
Bulletin No. 14. Irrigation Experiments of 1905.
Bulletin No. 15. Fertilizer Experiments, 1897-1905.

In addition to these publications, all of the early issues of the Experiment Station bulletins from 1895 to 1903 have been reprinted, two bound volumes of the same being sent to each plantation in the islands. In the reading of the large volume of proof for these reprints, Messrs. Peck and Thompson rendered very material assistance to the Division.

BUSINESS OF THE STATION.

In January, 1905, the Business Department of the Experiment Station was placed under the general management of the Director of the Division of Agriculture and Chemistry. While the duties of this officer have been unusually exacting during the past twelve months, owing to the many lines of work being pursued, this transfer was rendered possible through the very systematic basis upon which Mr. C. H. McBride, the Experiment Station cashier, had established the conduct of the same prior to this change. With occasional temporary assistance in the office, Mr. McBride has attended to all of the stenographic and typewriting work of the three Divisions, besides keeping the books and attending to mailing of bulletins, filing of reports, etc., and deserves special commendation for the excellent services rendered. Mr. McBride also made a verbatim report of the proceedings of the last annual meeting of the Hawaiian Sugar Planters' Association.

STAFF OF THE DIVISION OF AGRICULTURE AND CHEMISTRY.

No changes in the Staff of this Division have taken place during the past year, the officers being:

C. F. Eckart, Director.
S. S. Peck, Assistant Chemist.
Firman Thompson, Assistant Chemist.
F. R. Werthmueller, Assistant Chemist.
A. E. Jordan, Assistant Chemist.
E. G. Clarke, Agriculturist.
T. Lougher, Field Foreman.

The laboratory work of Messrs. Peck, Thompson, Werthmueller and Jordan has continued to be of the same high order as that shown in the past, while in the field Messrs. Clarke and Lougher have rendered valuable assistance in the carrying out of the usual agricultural experiments and in the propagation of the young seedling canes.

Respectfully submitted,

C. F. ECKART,
Director, Division of Agriculture and Chemistry.

Honolulu, T. H., October 12th, 1905.

(APPENDIX II.)

REPORT OF THE DIVISION OF ENTOMOLOGY.

To the Experiment Station Committee, Hawaiian Sugar Planters' Association, Honolulu, H. T.

Gentlemen:—I beg herewith to submit the Annual Report of this Division covering the year ending September 30th, 1905.

MISSION TO AUSTRALIA AND FIJI.

In May, 1904, Mr. Koebele and myself visited Australia chiefly in search of such parasites and predaceous insects as might be imported here to reduce the numbers of the cane leaf-hopper, and incidentally to do such other economic work for the benefit of the sugar planters or for agriculture in general as might be possible.

Having remained throughout that part of the year in which it was practical to do work on the cane leaf-hopper, I returned in January to Honolulu, Mr. Koebele, after my departure, going to New South Wales to look into other economic questions, and subsequently to Fiji, to study leaf-hoppers and their natural enemies in those islands.

As I was still in Australia at the time of the last annual meeting of the Hawaiian Sugar Planters' Association, I was only able to furnish that meeting with a very brief and crude account of the work we were carrying on there.

This work consisted of as complete a study of leaf-hoppers and their enemies as we could possibly make in the six months that we spent in Australia, and in the collecting and forwarding such species of the latter as seemed to us most likely to prove of use against the leaf-hopper in these islands. Many other beneficial insects were collected and despatched to Honolulu.

Consignments of insects were accordingly sent on nearly all steamers leaving Australia for the islands, though sometimes the date of sailing of the boats on the two lines happened to so nearly coincide, as to preclude the possibility of collecting material in the short interval between them; and sometimes the coast steamers from Northern Queensland rendered close connection with one or other line impossible.

Many thousands of living beneficial insects in all were shipped from Australia, and various devices adopted for getting them over alive and in good condition. To anyone acquainted with the difficulties to be overcome in work of this kind, especially in the case of creatures of excessively delicate constitution, as many of these are; and in the case of others accustomed to tropical heat, to which the temperature of the cool chamber on the steamer proved always fatal, it will not be surprising to learn that the mortality was very great, and it is unlikely that one individual in a thousand of the most important species of parasites sent over, reached this country alive. In fact it would appear that in some cases consignment after consignment was without result, and only by long continued sending was the desired result finally and with difficulty attained.

As far as the parasitic insects are concerned, it is doubtful whether more than a score of any one species ever arrived alive, while of most of them but three or four individuals withstood the long journey.

Until my return all the insects sent were tended by my assistants Messrs. Terry and Swezey, but on my return I myself took over the parasitic species, so that my assistants might be free to again undertake the inspection work of the plantations, which had necessarily been suspended.

In general the first attempt to establish the parasites in the open was made at Oahu Plantation, this being conveniently near to town, and possessing a sufficiently large crop of leaf-hoppers, as to insure a rapid increase and spread of any beneficial insects established there. Subsequently, however, after my return, all first attempts at establishment of parasites were confined to the Experiment Station cane, some plats of this being in a very favorable condition for such work.

The history of the most important of these parasites was as follows:

Four individuals bred from a Queensland cage were transferred to a cage with young cane containing hopper-eggs, January 17th-30th.

Three weeks from the first date the first parasites were reared from these and others up to February 24th, in all 46.

It should be remarked that probably only two of the original specimens were the parents of the forty-six, because the new cage had to be prepared at a moment's notice, and the cane was in a far from satisfactory condition. The life of the individual parasites being only 3-5 days, it is doubtful whether some of them laid any eggs at all.

The resulting 46 were divided into several lots; 16 specimens were liberated in the Experiment Station grounds, while 30 were retained for stocking other cages. As a very heavy rain followed the liberation of the 16, it is quite possible that most or all of these perished. The next generation, from the 30 retained for breeding, was a large one, and the individuals were no longer counted; many were liberated in the Experiment Station grounds, or confined on growing cane plants, by enclosing these in muslin sleeves, and this process was kept up for several further generations. By the middle of June specimens could be obtained at large almost anywhere in the grounds of the Station, though hardly yet numerous. Some weeks prior to the date of writing (Oct. 10th) they had become extremely numerous, 50 per cent. of the hopper-eggs being affected, and they now outnumber species established earlier, by at least 90 per cent.

DISTRIBUTION OF BENEFICIAL INSECTS.

As soon as they could be obtained in sufficient numbers, distribution of the parasites to the many plantations commenced. This distribution was begun in January, and has been continued up to date, as the several species of parasite became available. Except for an interval of a week or two, after one species of parasite had been everywhere distributed, and the next one was yet too scarce to be available for distribution, consignments of parasites varying in number from 3 or 4 to a score have been despatched every week to some or other of the plantations. All these were sent out in such a manner as would aboslutely insure their establishment, by carrying out the very simple directions sent with them; in fact all that remained to be done was that the cages should be placed in a suitable spot on the plantation. In no case that has been investigated, and where sufficient time has elapsed since the parasites were sent, have these failed to establish themselves.

On the whole it may be said that, so far as can be at present investigated, the results are satisfactory. In the Experiment Station grounds in the patch of cane most affected by hoppers, at the present time, as has been said, about 50 per cent. of the eggs are parasitized. Whether with hoppers more abundant, and in the colder months, and after a longer period, this percentage will increase or decrease, it is impossible to say. Briefly, we do not know whether these parasites have already after a few months reached their maximum increase or not, nor do we know how they will act under different conditions of temperature and weather, etc. Time alone can show this; but, as can be demonstrated to anyone that has eyes to see, entomologist or otherwise, the parasites now are at least destroying millions of hoppers to the acre under conditions favorable for their multiplication, so at least there is this much gain. It is also to be noted that one important egg-parasite is as yet too lately established to be efficient, because of the length of time that it requires to complete its life cycle.

Thus taking the life cycle of the first mentioned parasites as 20 days, and supposing each female (the species being almost entirely parthenogenetic) to produce 20 offspring, at the end of about 8 months a single female would have the incredible number of four thousand and ninety-six million million descendants.

On the contrary the second mentioned parasite, although it be twice as prolific individually, producing 40 offspring instead of 20, and being also parthenogenetic, but taking 40 days for its life-cycle instead of 20, would at the end of eight months have produced only four thousand and ninety-six million descendants, *or a million times less than the other.*

Of course such facts as these had to be considered in deciding to what enemies of leaf-hoppers we should give our chief attention in Australia. Other parasites unquestionably could have been introduced thence, had we devoted all our time to them, instead of to those selected, but similar results could not have been attained in a similar time.

Thus to take the other extreme a parasite producing 1000 surviving descendants in a generation, but only one generation a year, would at the end of the year be but 1,000 strong, and would take five years to become one-fourth as numerous as a parasite of the first named class becomes in eight months.

Of course the case is far more complicated than these simple figures show; one has to consider the nature of the parasite itself, the enemies that may attack it, when introduced, the suitability of climate, and many other such facts. Thus, owing to its more robust and sturdy constitution, it may be that after some years the parasite of the second kind mentioned may outnumber that of the first for this reason. The maximum number that a parasite can attain by no means always depends on the number of its prey, i. e., the food available, but often on most complicated causes at present little investigated or understood, though of primary importance to the economic entomologist.

INSPECTION OF PLANTATIONS.

Before the Entomological Division was organized it was arranged that a regular inspection of the plantations should take place at intervals by entomologists of the staff. This has accordingly been done, though for some time, at a period when large consignments of beneficial insects were being sent from Australia, it was necessary that the inspecting entomologists should leave inspection work and attend to these.

This inspection is very necessary and important, firstly because any insect new to the cane fields, and which may be considered a potential pest, would probably be detected long before it arrived at excessive numbers; and that there now are, and always will be, some that require watching is a certainty; secondly, the reports furnished by the inspectors are uniform, and the condition of different plantations with regard to different pests can be accurately compared. No doubt many managers could furnish excellent reports on the common insects, but the personal equation must largely enter into these reports and render them quite valueless for purposes of comparison. For instance what one manager considers a bad attack of leaf-hopper might actually be considered a period of relief by another!

I have collected the results of the inspection as regards leaf-hopper and cane-borer, at present our two worst cane pests.

A.—LEAF-HOPPER.

The last 38 reports of the entomologists, who are at present engaged in the round of inspection, were all made during the present year, between February and the present time. It appears that few or none were made at the time the leaf-hopper happened to be at its worst. Thus reports received from Hawaii some weeks after inspection, showed less favorable conditions than was the case at the time of inspection, as indeed was to be expected. Similarly, later reports often speak of the signs of past bad attacks, though now the hoppers are not very numerous.

Making some allowance for this the 38 plantations may be put in three classes, as to the condition of leaf-hopper attack during the past year:

'Very bad'	5
'Bad or bad in localized but considerable areas'	16
'Not bad'	17
	38

In order that there may be no misapprehension as to the meaning of the terms employed, I give examples of the 'very bad,' 'bad,' and 'not bad' as classified by me from the Entomologists' reports:

'Very bad': "Exceedingly bad, thousands of hoppers to every stalk, some fields very badly injured."

'Bad,' or locally bad: "Generally distributed; in several fields bad in places, causing considerable injury."

'Not bad': "Leaf-hoppers scarce throughout plantation, not enough to be injuring the cane."

As I stated some years ago would be the case, the plantations that suffer most one year do not by any means necessarily suffer equally in another. Thus during the first half of this year, while of some plantations it is said "not so bad as last year," others say "fully as bad as last year" or "worse than in any previous year."

Many reports speak of Yellow Caledonia cane as better able to withstand a heavy attack; in one case at least, however, this variety of cane is noted as being most attractive to the hopper.

Again it is a general rule that plant cane is more heavily attacked and suffers more than ratoons, as indeed has long been known to be the case; but striking exceptions to this were noted.

B.—CANE-BORER.

The cane-borer has always been a cause of loss to the sugar planters of these Islands, though it is only a matter of concern on certain plantations.

On going through the inspection reports, I find that in about twenty plantations it is abundant enough, either extensively or locally, to do considerable damage. As is well known, it can at the expense of much labor be more or less completely kept down by hand-picking and by careful burning of trash after the crop is taken off. Mr. Koebele visited several countries in search of natural enemies, but found none, nor is it probable that he ever reached the native home of this beetle, which has now spread over a very wide area, and has, we know, been repeatedly introduced into these Islands from outside. That some enemy may be discovered, which will largely diminish the injury caused by the borer, is by no means impossible, and the attempt should certainly be made again, notwithstanding the negative results of the past.

Mr. Muir, who has lately joined the staff of the Station, will make observations on the causes of decrease of borer, which is said to be great since Mr. Koebele visited Fiji, on some of his earlier missions to those islands.

VISIT TO OTHER ISLANDS FOR PURPOSES OTHER THAN OF INSPECTION.

In May, Messrs. Swezey and Terry both visited other of the islands, the former going to various plantations on Hawaii, and also to Maui, to establish colonies of an important parasite on such plantations, as the several agents especially desired should first receive this, when it first became available. Mr. Terry visited some other plantations on Hawaii with the same object, and also spent considerable time on Oahu Plantation, supplying me with material for distribution to the plantations. Some of the plantations on this island were supplied with similar colonies at almost the same time, in each case one of the Station entomologists being sent to establish these.

WORK AT THE STATION.

A large stock of living beneficial insects, parasitic and predaceous has always been kept at the station, until quite recently. Attending to these, and providing them with food, and the collection and despatch of various species to the plantations, has largely occupied the time of the entomologists. It is quite possible that the individual plantation manager does not always fully realize the work necessary to supply about 50 different plantations, many of them extending over miles of country, and consequently wanting several consignments of each, with various kinds of beneficial insects, all within a few months of their first arrival into this country, while they are still only to be obtained in limited numbers. As the insects become more common this work becomes much easier, and after a time the manager himself can arrange that all new fields of cane are stocked from the old ones; indeed in some cases this can be, and already is being done.

In the intervals of this work a large part of the preserved material collected in Australia and Fiji by Mr. Koebele and myself was prepared for study, and a number of the cane-field insects connected with leaf-hopper were specially studied as to their habits and life histories.

PUBLICATIONS.

In May a bulletin entitled "Leaf-hoppers and Their Natural Enemies" was begun and is being issued in parts, four parts having been published up to date, and either two or three other parts will be issued before the annual meeting of the Association, since the manuscript is already completed. In fact this work is considerably further advanced than this statement would suggest, for Mr. Kirkaldy, to whom the major part of the large collection of species formed by Mr. Koebele and myself, was given for classification and description, is already far on the way to completing the study of these, and in addition to this, one or two other parts and the general introduction alone remain to complete the bulletin. It is hoped that it may be brought to a close by the end of the year.

It would have been highly desirable that twice or thrice the time should have been spent in studying the large amount of material that we collected, yet experience has shown that in an Experiment Station, whose members are all engaged in practical economic work, if the scientific and practical results of any mission be not published while the work is still in progress, some new questions of economic importance will arise, and the labor of months or years goes unrecorded. Thus it has been with the results of most of Mr. Koebele's former labors.

The first two parts of this bulletin were issued without any plates whatever to illustrate the many new species dealt with; but the next two were excellently illustrated by Mr. Chambers, though it was necessary to cut down the number of figures to a minimum, in order not to further delay the work. The time of completion of this and all bulletins of the Entomological Division will, it is clear, depend not on the entomologists but on the artists. It is perfectly clear that one artist, whose time is only partly given to entomological illustration, cannot possibly deal with more than one-fourth to one-half the minimum amount of illustration required to keep pace with the work of this Division. Consequently if there is not to be great delay in publication (and as I have already said, delay often results in no publication of results at all) one of several courses is open to us. Either we must engage one artist to work entirely for the Entomological Division, in addition to keeping such time of the artist as is now devoted to illustration for the Division; or we must send out of the country by far the greater part of the illustrated work we need done; or members of the Entomological Division must learn to do their own illustrating. Probably a compromise between the second and third alternatives can be satisfactorily arranged, and at very great saving in expense as compared with engaging an additional artist for the exclusive benefit of our Division.

LIBRARY.

The additions to the library, since the first selections were made, have not been great. Some of the books, however, particularly those most hard to obtain, and therefore most costly, which were ordered when the Entomological Division was first organized, have only recently come to hand.

It should be noted that among the most costly books in our library are many volumes dealing with general subjects, and not merely entomological. As these are necessary for general use in all Experiment Stations, it would seem more equable that the cost of these general works should be divided between the different Divisions, and not fall entirely on the Entomological.

The current literature on entomological subjects is large, and has been, and necessarily must be, kept up. With regard to rare and costly books or periodicals, which often contain articles which must be seen before a bulletin can be completed, arrangements have been made for copies of the articles to be made and sent to us from one of the great libraries. Though this will sometimes cause delay, yet the saving in expense will be very great.

Some time since, Mr. Kirkaldy was appointed librarian, and compiled a catalogue of all the books and periodicals, and certain rules were made for all members of the Station, when they desire to take out books for study. In brief no works that are in daily use, nor volumes of an important series, nor rare works, which the borrower could not replace quickly at his own cost should they be lost, and no monthly or other parts of periodical current literature can be allowed to be removed from the building. Such a rule is absolutely necessary for us, on account of our isolation, which would make the replacing of an accidentally lost work a matter of considerable time.

In conclusion it remains to thank those who have more especially assisted us in our work. The agents of the various plantations and the managers of these have done everything possible in this respect, whether in the matter of distributing beneficial insects, or of the inspection of the plantations. To Messrs. Irwin & Co. and Theo. H. Davies & Co., of Honolulu, we are particularly indebted for their kind offices in securing us introductions to other Shipping Companies in Australia and Fiji, and to those companies for doing everything possible to assist us in the careful handling of the insects despatched to Honolulu. We are also greatly indebted to the Colonial Sugar Refining Co., who helped us in every way in Australia and Fiji.

Respectfully submitted,

R. C. L. PERKINS,
Director, Division of Entomology.

Honolulu, October 17, 1905.

(APPENDIX III.)

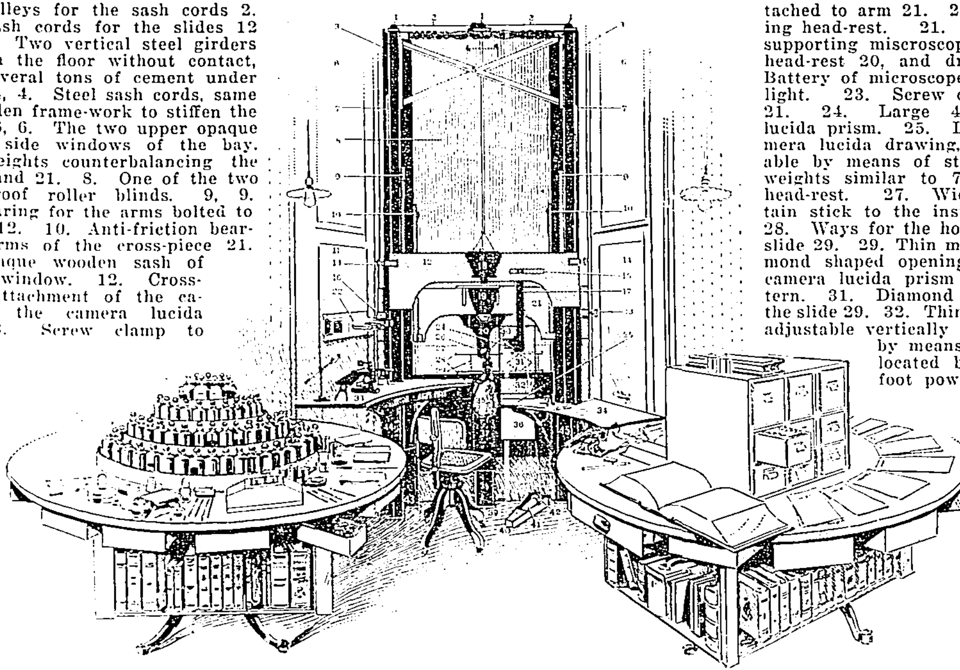
ANNUAL REPORT DIVISION PATHOLOGY AND PHYSIOLOGY.

To the Experiment Station Committee,
Hawaiian Sugar Planters' Association:

It is using a misnomer to call this an Annual Report, inasmuch as the Division of Pathology and Physiology has been in existence as a partially organied force for only about three months. Under the circumstances the energies of the Division have of course been devoted mainly to securing the proper facilities for its work in the form of laboratory equipment and land. I think I can not do better under the peculiar circumstances of the case than to describe at some little length the more original of the features embodied in the Laboratory.

The nature of this building has been mentioned in the Annual Report of the Chairman of the Committee on Experiment Stations, and the illustrations inserted there and elsewhere in this report give a good idea of its general appearance, both externally and internally. The features to which I will call particular

FIG. I.—MICROSCOPIST'S OUTFIT.



1, 1, 1. Pulleys for the sash cords 2. 2, 2. Steel sash cords for the slides 12 and 21. 3, 3. Two vertical steel girders passing through the floor without contact, imbedded in several tons of cement under the building. 4, 4. Steel sash cords, same as 2. 5. Wooden frame-work to stiffen the girders 3, 3. 6, 6. The two upper opaque sashes to the side windows of the bay. 7, 7. Sash weights counterbalancing the cross-arms 12 and 21. 8. One of the two similar light-proof roller blinds. 9, 9. Anti-friction bearing for the arms bolted to the cross-piece 12. 10. Anti-friction bearings for the arms of the cross-piece 21. 11. Lower opaque wooden sash of the left hand window. 12. Cross-piece for the attachment of the camera 18 and the camera lucida prism 24. 13. Screw clamp to cross-piece 12. 14. Lower opaque wooden sash to right hand bay window. 15. Slot in which the camera lucida arm 17 slides horizontally. 16. Clamp to the cross-arm 21. 17. Arm for the support of the camera lucida prism 24. 18. Ordinary camera attached to arm 12. 19. Microscope camera attached to arm 21. 20. Vertically sliding head-rest. 21. Wooden cross-arm supporting miscroscope camera 19, and head-rest 20, and drop slide 32. 22. Battery of microscope using direct sky-light. 23. Screw clamp to cross-arm 21. 24. Large 45 degree camera lucida prism. 25. Location of the camera lucida drawing, vertically adjustable by means of steel cord and sash weights similar to 7. 26. Pillow to head-rest. 27. Wide thin metal curtain stick to the inside roller blind 8. 28. Ways for the horizontal thin metal slide 29. 29. Thin metal slide with diamond shaped opening 31. 30. Small camera lucida prism of the usual pattern. 31. Diamond shaped opening in the slide 29. 32. Thin opaque drop slide adjustable vertically through foot power by means of simple pulleys located behind 17 and the foot power 40, 41 and 42. 33. Left hand adjustable leg-of-mutton shaped table. 34. Right hand adjustable leg-of-mutton shaped table. 35. Opaque dark cloth enclosing sub-stage of microscope, preventing access of extraneous light. 36. Aperture for the admission of light; glazed with ground glass and opened and closed by means of slide 32 and foot power 40, 41, and 42. 37. Steel sleeve carrying microscope and vertically adjustable on the pillar 38. 38. Steel pillar for support of microscope, passing through floor without contact and imbedded in several tons of cement under the building. 39. Aperture in floor for the passage of girder 38. 40. Spring-roller foot power for the control of drop slide 32 by means of the string passing around the pulley 42. 41. Spring roller of ordinary pattern covered with sand-paper to give sole of boot efficient grip. 42. Pulley turned by foot power and winding or unwinding the string which raises or lowers the drop slide 32. The weight of drop slide 32 exactly counteracts the spring of the roller 41. 43. Left hand steel girder at height of floor. 44. Steel sleeve sliding vertically on left hand girder and affording attachment for table 33. 45. Steel sleeve sliding vertically on right hand girder and affording attachment for table 34.

attention are those found in the Microscope Room, Illustration Room, and Dark Room.

THE MICROSCOPE ROOM.

For many years it has been customary in the best laboratories to mount various instruments of precision upon pillars of stone or masonry deeply imbedded in wells in the ground and passing upward through the floors of the laboratory without contact. The object of this arrangement is to prevent tremors, which are of constant and inevitable occurrence in an inhabited building, from being transmitted to the instrument; the earth receives these tremors, and, within the limits of the precision of the instrument, they are nullified. Galvanometers, seismographs, balances and other instruments are mounted in this manner. It is not often that the microscope has received such special attention, but wherever high powers are used and especially when photo-micrographs are being prepared, or whenever high power camera lucida drawings are being made, the reduction of vibration is an important factor in the success of the work. For many years the writer has had microscopes mounted in this way and hereby testifies strongly in favor of this method of using the microscope. The system is exemplified in the Laboratory of the Division of Pathology and Physiology, and as experience has added improvements to each successive plant erected, it may be worth while to describe this recent outfit.

The plan is carried out in cement and steel. See Fig. 1. Below the building is a large block of cement weighing several tons. In this block of cement three T-girders, two of which are approximately eight inches in each dimension, are imbedded vertically to the depth of about four feet. The central one of the girders carries the microscope, together with certain accessory apparatus connected with the illumination of the object. This girder is much smaller and shorter than the other two, extending only about eighteen inches above the floor of the microscope room. The other two girders are mates and extend to within about eighteen inches of the ceiling of the room; in other words, project upward into the room about eleven feet. The building being constructed of wood, the floors were laid about the pillars after they had been set in the cement and the whole structure was then given sufficient time to settle into its permanent position. This usually occurs in the course of a few months. When everything is settled into position, an ordinary key-hole saw is run through the floor entirely around the contours of the girders, so that at the end of the sawing operation the girder entirely clears the flooring and floor covering by the width of a saw blade. See 3, 43, &c., Fig. 1.

Needless to say the object of these girders is to afford attachment for all the necessary apparatus connected with the microscope. The girders at every part clear the walls of the building by a fair margin. It is, however, best to place all the girders as close to the microscope windows as is convenient. The reason for this will be explained on a subsequent page. In the present instance, the distance between the girders and the window casings is about one inch. The general principle on which the accessory apparatus is attached to the girders is that of sliding metal sleeves that may be clamped in any desired position. A sleeve of one-sixteenth-inch sheet metal surrounds the small central girder and projects outwards, that is toward the observer, sufficiently to form a base on which the microscope may rest. This base is from one to two times larger than the horse-shoe base of the microscope. This gives a sufficient amount of space so that the microscope can be readily arranged for different classes of work,—moved sideways in either direction or forward or backward. The sleeve carrying the microscope is clamped to its pillar by three set-screws, and by means of this simple arrangement the microscope can be raised and lowered to suit different operators and different classes of work. When, for instance, microphotographs are being taken, it is most convenient to drop the sleeve to its lowest limit, so that the microscope will rest on a base about fifteen inches above the floor. For most photo-micrographic work this will enable the operator to bring the focussing plate of the camera (19 Fig. 1) low enough to render it unnecessary for the operator to have any special step-ladder to assist him in obtaining an accurate focus. On the other hand, when it is necessary to place the microscope high and the camera lucida table low, one can obtain a distance as great as two and one-half feet between the level of the eye-piece of the microscope and the drawing table. This, together with the peculiar camera lucida, which will be described later on, enables one to make his original sketches of such a size as to allow for that liberal reduction in the subsequent photographic process which gives the best results for book illustrations. The sleeve which carries the microscope also carries a wooden front as wide as the microscope window and about two feet deep, in other words about three feet by two feet. This screen, which of course slides up and down with the microscope and its sleeve, carries two apertures. One of these apertures is in front of the microscope mirror and is designed to allow the light from the special outdoor illuminating screen to strike the mirror and pass through the microscope. The second aperture is of much larger size and is glazed with ground glass and is opened or closed as desired by means of a hanging slide worked by foot-power. The object of this second opening is to secure a correct illumination on the drawing board when the camera lucida is in use. See Fig.

We will next pass to a description of the microscope window. This faces the sun, and preferably faces precisely south. It is so fitted with light-proof roller blinds that the light may be entirely shut off or may be allowed full access. The roller blinds slide in lateral grooves ten inches deep. The depth of these grooves must be sufficient to prevent the blinds bellying through the action of the wind. It is found when a window is tightly closed with flexible blinds as is the case in this special microscope window, that the pressure of the wind is sufficient to cause considerable inconvenience unless the edges of these roller blinds are held in deep grooves. Should it be necessary to make a further provision against the bellying of the blinds they may be stiffened from place to place with one-sixteenth-inch wooden laths; or wires may be strung across the window. The blinds may be of any opaque material, but if they are very long, preferably of some thin material. The writer has found that ordinary green opaque window blinds can be sized black so as to become practically light-proof, and as it is advisable in constructing a light trap to have two blinds, he finds that with two such blinds the light is wholly excluded, and if necessary the room can be used as a photographic dark room. The wooden rollers used are of the ordinary pattern and present no special peculiarity. They are built in or boxed in at the top in a light-tight manner.

We turn next to the various sleeves sliding on the long upright girders. Of these one of the most important is the right-hand lower sleeve which carries a leg-of-mutton shaped table for use in connection with the production of camera lucida drawings. This sleeve as well as all the others, is balanced with a sash-weight, so that it moves with the utmost freedom either up or down through a space of about four feet. The table may therefore be placed within fifteen inches of the floor, or it may be raised to a distance of three feet. This adjustability is found to be highly convenient in the production of camera lucida drawings of definite magnification. The peculiar shape of the table has been evolved from practical experience during many years. In general, its form is such that when taken together with its mate on the other side of the microscope, it presents a semi-circular curvature which gives the investigator a free play for hands and body. This table is painted black, as are all the other accessories used in this system. See 32, 34, Fig. 1.

Turning to the left-hand side of the microscope, we find an entirely similar and symmetrical sleeve and table which, however, is used for a very different purpose. This sleeve carries the mate to the camera lucida table and of course, in the case of a left-handed operator, could be used in the same way as the right-hand table would be used by a right-handed operator. The usual position for the left-hand table is about on a level with the microscope stage. This height is found to be convenient for several reasons; first, under ordinary circumstances, it is about ordinary table height and is convenient for supporting the dissecting microscope, which, as explained later on, has a special illumination of its own. Thus in the preparation and examination of objects, the dissecting stand is as close as possible to the examination stand and the objects may be transferred from one to the other with the greatest convenience; a second reason for having the left-hand table on a level with the stage of the microscope is that the preparations may be moved on and off the stage of the microscope with the least danger and with the greatest facility. A third reason is that in this position the left forearm finds it a most convenient rest in working the fine adjustment screw. In addition to the three sleeves already described, the long girders carry two cross-pieces for the attachment of various accessories. These wooden cross-pieces slide up and down and are weighted with sash weights so that their adjustment may be quickly and easily accomplished. In order that the friction on the girders may not cause any inconvenience, arms extend upward from these cross-pieces for the purpose of carrying pulleys which are in contact with the edges of the girder and so reduce the friction. These cross-pieces are clamped in position by set-screws at the side. It will be at once evident that these cross-pieces may be used for the attachment of a variety of accessories. Among the more important of these is the microscope camera. See 19, Fig. 1. This hangs above the microscope and is ever in readiness for instant use. The camera itself presents no very peculiar features. It is of course a vertical pattern carrying the exposed photographic plate in a horizontal position. It cannot be used in a horizontal position. Experience has shown that the vertical position has very many advantages and that if one is confined to a single outfit, the vertical outfit is the better, providing its attachment can be of the nature here described. In obtaining the focus, the cross-piece carrying the camera is loosened by unclamping the side screws and is then moved upward and downward against the sash weights which counterbalance it. A scale is marked on the girders so that the various magnifications are at once obtainable, or they may be obtained by special measurement in each case. The apparatus never needs any levelling, being, as before said, constantly ready for use. The operator loosens two hooks and the camera drops instantly into position. The whole is ready for use in a few seconds' time. If the photograph is being taken with a high power and the illumination is therefore weak, and the exposure consequently long, one leaves his instrument during the exposure with the greatest confidence that nothing can disturb it. Any tremors in the building will not be received either by the microscope or the photographic plate. A second attachment of great importance for the production of illustrations is the

CAMERA LUCIDA.

This presents a number of peculiarities. Fig. 1, 17, 24. The history of the camera lucida is a very interesting one. It is impossible to go into its details here, but nothing is clearer than that this instrument is one of great importance to the microscopist, and its history is in accordance with this fact. The utmost ingenuity has been exercised to produce an instrument by means of which sketches of small objects can be made with the aid of the microscope. The necessity for this class of work is very great. The photographic camera does not materially assist us with most subjects. Only in the case of exceedingly thin sections or natural objects of great thinness is a photomicrograph satisfactory. In all other cases in order to fully elucidate the structure by means of an illustration it is necessary to obtain the appearance at different depths in the preparation. This can only be done by focussing the microscope for each particular portion of the structure. This fact, thus hastily explained, is what makes it absolutely necessary to use a camera lucida for the proper representation of most microscopic objects. This fundamental necessity is what has given rise to the many patterns which the camera lucida has taken on during the course of its history. The first instrument was an extremely simple one. From time to time improvements and additions have been made until at the present time the instruments issued by the best makers are marvels of ingenuity and workmanship. In fact, in the writer's opinion they are almost too ingenious, for it appears to him that the various additions which have been made to the camera lucida during recent years, while they do accomplish the object aimed at, do so in an unsatisfactory manner.

In order to produce a good camera lucida drawing, it is necessary to have a certain degree of light passing through the microscope enabling the operator to see the object with the greatest possible clearness. It next becomes necessary to so modify the light from the drawing board as to enable him to see his drawing point with the greatest possible clearness. It next becomes necessary to so modify the light from the drawing board as to enable him to see his drawing point with the greaest possible clearness. Now, with most objects it is not possible to secure this adjustment once for all, for all portions of the drawing. Different portions of the object emit different amounts of light, and, as the light varies, it is necessary, in order that the drawing may be made with the greatest precision and facility, that the light from the drawing board should be modified accordingly. The accomplishment of this end has been sought in a variety of ways, and this more than any other thing has added to the complexity of the modern camera lucida. When the modern instrument is in good order, it does, as we have admitted, in a way accomplish its object. The difficulty is that it is easily thrown out of adjustment, and easily becomes soiled and dusty so as to be a hindrance rather than a help. Again, no device has yet been furnished by manufacturers which enables one to modify the light except by a series of steps. It is usual to insert or remove a certain number of tinted glasses until the right degree of light has been secured. It often happens that the precise tint required can not be secured at all. In any case by this method there is always being inserted between the eye and the object, various pieces of apparatus which can not be regarded as other than necessary evils. It is needless to go into the particulars of instruments made by different makers. What has been said has a general application. A second defect presented by many of the camera lucidas, is the double reflection due to a silvered mirror. The thickness of this mirror has been carefully adjusted so as, as far as possible, to superimpose the various images one on the other, but it is impossible to get rid of the double reflection, and while this can be tolerated for a short time, if the instrument is in use for a considerable length of time, say several hours, this double reflection of the pencil point becomes very tiresome to the eye.

Any form of camera lucida is an instrument well-calculated for the destruction of eye-sight. The writer has during many years of experience been endeavoring to reduce the injury to eye-sight in connection with the use of the camera lucida, and the following suggestions, embodied in the outfit here described, are the result of his experiences. In the first place, he has substituted for the ordinary mirror a 45° prism. Fig. 1, 24. The advantages obtained by this substitution are as follows: 1. The prism may be of any desired size so that it may be mounted at a considerable distance from the eye-piece of the microscope. This secures an increased magnification of the drawing, and the advisability of this increased magnification will be dwelt upon on a subsequent page. 2. A second advantage in the use of the prism as a reflector is the disappearance of the double reflection, and the securing of a total reflection. The light passes from the drawing-point through the lower face of the prism in a nearly perpendicular direction and with very little loss. It is then totally reflected from the oblique face and passes outward nearly at right angles to the vertical face, again with very slight diminution. The loss of light is therefore considerably less than in the case of the usual mirror, in addition to the securing of a total reflection destitute of doubles. 3. A third advantage and one of considerable importance is the stability of the apparatus here described; it rarely gets out of register.

The second modification is that which has been referred to on a previous page, as the blind worked by foot-power. Fig. 1, 32. The object of this blind is to illuminate the drawing with any degree of light at an instant's notice and to do this without in any way disturbing the adjustment of any part of the microscope or camera lucida. This is a matter of very great importance in the rapid production of good camera lucida drawings. If often happens that the light coming through the instrument is so faint that it is only by shutting the light quite off from the drawing that the investigator can see the details of the sructures to be sketched. This darkening has in the past been accomplished in various ways. It has for instance been accomplished by having a pencil on the butt end of which is a feather to be flirted in between the eye and the drawing board so as to obliterate the image of the latter. There are other methods of accomplishing the same end. With the foot-power arrangement, the light is shut off or let on without the operator's disturbing the position of his body or his drawing-point. Moreover, the light can be so modified as to instantly bring about that adjustment which is most favorable for any particular part of the sketch. To describe the whole operation briefly, we may say that the operator's left hand rests on the left-hand leg-of-mutton table on a level with the fine adjustment of the microscope. His left hand therefore is in a position to work the fine adjustment screw with the greatest ease and facility, and the most careful adjustments of focus can be easily accomplished. His right hand carrying the drawing-point rests on the drawing board and is engaged in the production of the sketch. As the light required for the various portions of the drawing varies he can by a slight movement of his right foot, which in no way disturbs either of his hands, and in no way disturbs the equilibrium of the instruments, effect the desired illumination of the drawing. It is found that the drawing surface best adapted to the production of camera lucida drawings is a dark, and, preferably, black surface. On this surface a white drawing point should be used. For most objects this is a considerable improvement over the ordinary pencil used on white paper, as will be at once admitted by any one who makes a trial. The method found most effective in this laboratory is that of using a thin black tissue-paper which is blued on the under side. A piece of enameled board of suitable size for the drawing is placed on the drawing board, i. e., the right-hand leg-of-mutton table, and it is then covered with the black tissue-paper with the blue side down. A tracing is now made with a white ivory point. This results in the production of a blue outline drawing on the enameled board. This sketch is put aside for further reference, or for the production of a finished drawing whenever necessary, or may be finished up at once. The object to be secured in this blue sketch is a sufficiently good representation of the object to be illustrated which shall have sufficient size to admit of a liberal reduction when the drawing is photographed on metal preparatory to etching. Thus, if it is desired to publish an illustration having a magnification of 500 diameters, it is advisable to produce a blue sketch at from 1,000 to 2,000 diameters. This is easily accomplished with the apparatus that has been described. By placing the prism reflector at a considerable horizontal distance from the eye-piece of the microscope, say one foot, and lowering the right hand leg-of-mutton table sufficiently, magnifications of liberal dimensions are easily secured. Needless to say the production of a large coarse drawing is an easier matter than the production of the same drawing on a smaller scale, so that the operation is not only better, but considerably easier if carried out in the manner described. It is unnecessary to go into the details of converting the blue sketch into a pen and ink drawing. These present no peculiarities. It ought perhaps to be mentioned that the object of using the blue color is to avoid trouble through the alterations that may be necessary in finishing the drawing. Any light blue lines which are left on the enameled board need not be removed, as they do not affect the sensitive photographic film sufficiently to cause any inconvenience in the production of an etched block. The black tissue paper mentioned is produced by inking ordinary tissue. The ordinary blue carbon paper gives too dark a blue to meet the requirements. The blackened tissue is rubbed on one side with dry Prussian blue powder. This gives a light blue tracing.

At an earlier stage it has been mentioned that all the accessories in connection with the microscope are painted black. In addition to this precaution, arrangements are made such that the room itself can be darkened, in fact, converted into a photographic dark-room at will. This object is secured by having all the window blind connections light-tight. The oblong aperture, about five inches by eight inches, through which the microscope receives its light, is screened by means of several thicknesses of flexible black cloth made into the form of a sleeve. This cloth sleeve attached around the perimeter of the opening, is notched above so that it surrounds the microscope just beneath the stage and buttons onto one of the screws at the back of the microscope. No light reaches the eye except that which comes through the instrument. If, now, the slide in front of the large glazed aperture be closed and the room be darkened, the operator sits in absolute darkness. Any one who has had experience with a photographic dark-room, must have observed how after a period of from five to ten minutes therein the eye becomes accustomed to the darkness of the room and is able to distinguish objects much more readily than at first. This is a principle which can be utilized to very great advantage in connection with high-power microscope work. In fact, the writer is of the opinion that it is this contrast between the external and internal illumination which leads so many operators to use artificial light, and even in some cases to prefer working in the evening. Certain it is that if the surrounding light is dim and the eye is allowed to adjust itself to this dimness, then ebtaf. ved,sIbdmhshrdlu shrdl cmfwycmfwyp mfwypcmfwypnnn on looking through the microscope, details may be seen much more clearly than in any other way. It is often painful to witness the unconscious efforts of microscopists to bring about this condition as fully as possible by means of awkward attitudes and facial expression. It is not at all uncommon to see the microscope placed in a glare of light with a strong light beating on the top of the object and confusingly reflected up through the microscope, and to see the operator sitting in a cramped position, bringing his head over the top of the instrument so as to shade his eye as much as possible, and then often drawing the eye-brow down to assist in the same object. I take it that all this is simply an unconscious effort to give the eye the benefit of a weak extraneous light. With the present apparatus, these difficulties disappear. The room is darkened. All light which could possibly get to the operator's eye is excluded, except that which comes through the microscope. There is no light coming upon the top of his object to cause confusing reflections in the microscope. The image is as clear as it can be made and the eye is given every facility to see this image and is distracted by no others. Needless to say, the apparatus is a daylight apparatus. It hardly seems necessary to argue that as daylight is the light which has developed the human eye it is the light to which it is best adapted. Images produced by diffused daylight must be the best that can be produced on the retina of the human eye. This seems a sufficient argument for the use of daylight and a sufficient explanation of its superiority to every other light. However, when all this is said, it is not possible to always secure and control this natural light so as to get the best results. The following contrivances are such as experience has shown the writer to be very useful for this purpose, especially in sunny climates. Outside of the microscope window a universally adjustable white screen is placed in a sunny position, preferably not more than ten feet away. The surface of this screen may be of any white material. It can be made of wood, painted white, or lined with plaster of Paris, or, what to the writer seems almost equally good, a plain wooden screen covered with several thickness of bleached cotton cloth. It is better if this screen can be adjusted from the interior of the microscope room, but this is not essential. If a small mirror be attached to the screen, it will indicate the position of the screen that will reflect to the microscope mirror a maximum of white light. Place the screen so that the flash of sunlight from the mirror strikes in the vicinity of the microscope. Then of course, the whole of the screen will be in a corresponding position and will be reflecting a maximum of light. It is found that if the screen be placed in this position for several hours the light from it remains practically constant, so that while an adjustment by cords from the interior is a convenience, it is not a very great necessity. If an adjustable screen is not available, it is generally best to arrange one or two fixed screens and thus accomplish the same object, one screen for morning and another for afternoon. The light from a blue sky is not a satisfactory light. A white cloud gives a very good light, but clouds are such fickle things that it is not wise to rely upon them where the microscope is in constant use. It is much preferable to construct a screen that will be available in a fixed position whenever the sun shines. When the sun does not shine the sky must serve.

It remains to say a few words in regard to the dissecting microscope. This, as before mentioned, rests on the left hand sliding table. The main microscope window is flanked by two narrower windows, (forming a "bay") each of which is fitted with opaque wooden screens sliding up and down with sash weights. Whenever necessary, these screens can be raised and the light necessary for the preparation of objects secured. The object ready for examination, the screen is dropped, the room is darkened and the examination with the compound microscope proceeds. The screens just described have a second purpose in the carriage of batteries of accessory microscopes. It is often convenient in making comparisons to have several microscopes in operation at one time, even where, on account of the cost, it is not feasible to furnish complete outfits. To meet this end, cylindrical barrels capable of carrying objectives and eye-pieces are mounted in batteries on the screens and are pointed at the sky. The outfit that is found most convenient for each unit of this battery is as follows: a rather high-power eye-piece, a barrel 160 mm. long capable of carrying the ordinary objective, and two objectives, one of which is a moderate power corresponding to a one-sixth Bausch and Lomb or a Zeiss "D," and the other a two-third objective or Zeiss "A." In the wooden stage, a small section of tubing of the same size, and capable of carrying an objective, is used to carry the lower power of the two objectives. It is found that by pairing these objectives with care the low power objective furnishes a first-class achromatic condenser for the high power. It is surprising what good results may be obtained with this simple apparatus.

The other features of the outfit are sufficiently displayed in the illustrations. The rotating tables are of the usual type, though above the usual size. They carry five by eight swing drawers and hanging shelves for books and instruments.

THE DARK ROOM.

A peculiarity of the Division dark room that deserves mention is its illumination. This is carried out on a plan that has often been adopted for small dark-room lamps, but has not hitherto, so far as the writer knows, been carried out on a large scale adapted to daylight as well as artificial light.

The non-actinic or "safe" light for the dark room is obtained by passing daylight through suitable solutions, and the illumination is from above after the manner of numerous patterns of small dark-room lamps. The dark room window is placed somewhat higher than is usual and its upper sash is boxed in in a light-tight manner. The box is prismatic in form: one side is parallel to the side of the dark room, in fact coincides with it; another is perpendicular to the side of the dark room and forms the horizontal bottom of the box, while a third is at an angle of 45°, such that when a mirrow is fastened on its inner surface it reflects the sky light, which comes through the window and throws it downward upon the dark room sink and developing board. On the bottom of this prismatic box, there rests a tray, or a number of trays nested one over another, for the reception of the various colored fluids used as light screens. One of the most useful of these fluids is a concentrated solution of bichromate of potash. It is found that ordinary daylight or sunlight on being passed through from eight to twelve inches of concentrated solution of bichromate of potash is a very sufficient and satisfactory light in the dark room, especially when it is reflected from above in the manner described. The mirror used for reflecting the light downwards is preferably of corrugated glass, though plain glass answers the purpose. The box contains an electric or gas light so that it is available for evening work. The amount of comfort to be gained from an ample illumination in the dark room is something that should not be overlooked, as the frequent passage from the dark room to an illuminated room is a trying matter, even for the best of eye-sight. The amount of illumination which may be secured by adopting the plan here described may be readily judged when it is said that during development ordinary type can be read with the greatest ease, so that it is rather a misnomer to call the room a "dark" room.

THE ILLUSTRATION ROOM.

Several of the rooms of the Laboratory of the Division of Pathology and Physiology are specially fitted up for the use of solar projecting apparatus. This projecting apparatus is primarily for the purpose of projecting negatives and microscope preparations from which illustrations are to be prepared, and in some ways the apparatus thus used takes the place of the ordinary camera lucida, and for the class of objects to which it is suitable, it affords many advantages over the camera lucida. It is, however, limited in its application so far as the microscope is concerned as it is impossible to use the highest powers of the microscope in this manner. A second use to which the projector will be put is the projection of images of microscopic objects which are under examination and which it is desired to show to more than one person at a time to facilitate discussion and study. Needless to say the projector can be used in the same manner as an ordinary stereopticon or magic lantern, with the advantage that, as sunlight is more powerful than any artificial light, much better images may be secured. It is also needless to say that the instrument has the inevitable drawback that it can be used only when the sun shines.

When the instrument is used in the production of illustrations, it is customary to project the negative, or preparation, upon a glass screen of special character. The object of the screen is to secure to the artist that freedom of movement which comes from relieving him of the drawback which is usually presented by the shadow of his own hand and person. The projector has often been used for the production of illustrations, but the writer is not aware that the present method has been hitherto exploited, except in his own private laboratory, namely: the use of so powerful a light as to enable the operator to throw the image through ordinary cartridge paper, thus enabling him to work on what may be called the backside of the projection. This method is an expeditious one and is a very great gain indeed from an artistic point of view. It is a gain from almost any point of view, but it particularly gives a freedom of treatment that has to be experienced to be fully understood. It is found that the projector when used in this way facilitates the production of illustrations from negatives so poor that they would not make a print suitable for reproduction by the half-tone or any other process. Furthermore, it often happens that negatives contain objectionable features that it is not desirable should appear in the illustrations. When a drawing is prepared from the projection of such a negative, the objectionable features can be omitted. Again, the desirable features of several negatives can be combined and in this way results can be procured which would be procurable in no other. As to the details of the apparatus, little need be said so far as the projector itself is concerned. It is of the ordinary pattern consisting of an adjustible mirror capable of throwing the parallel rays of sunlight through a large condensing lens. The cone of light produced in this manner is passed through the negative or preparation and the light is brought to a focus on the screen by means of an objective. This objective may be a simple cheap meniscus, or may be a photographic lens, or a microscope objective. All these forms are in use in the illustration-

Solar camera as used to facilitate the production of illustrations from negatives and from transparent objects.

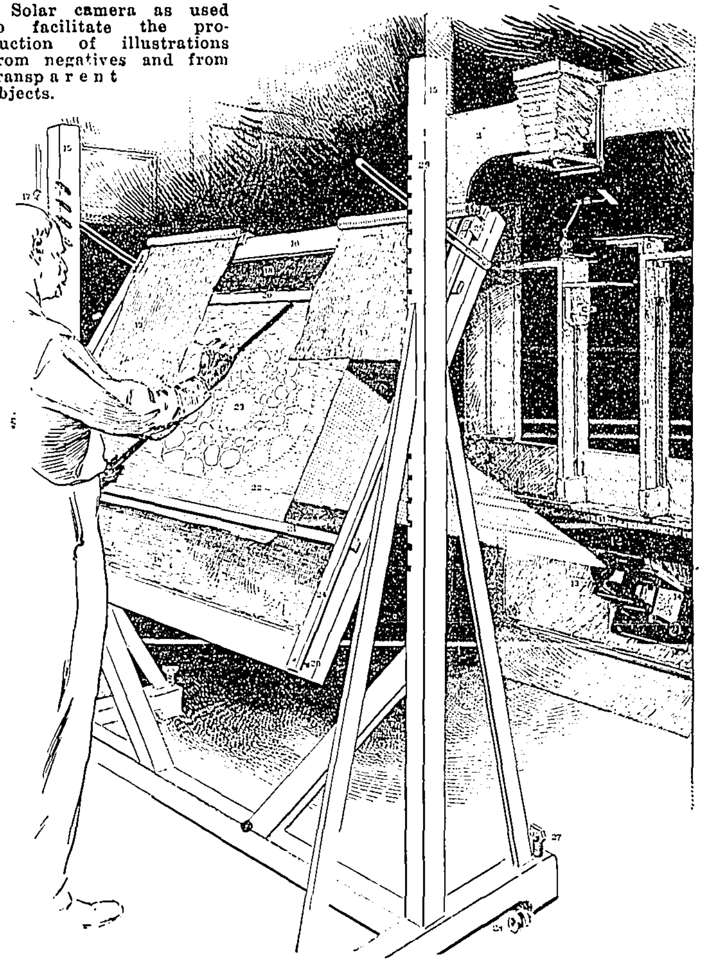


Fig. 2. 1, steel girder to left of window affording part of the support to the ordinary camera 3; 2, cross-piece supporting camera 3; 4, support for camera lucida, same being here represented as attached to an ordinary lens carrier; 5, vertically adjustible horizontal platform; 6, drawing board; 7, horizontal ways for 6; 8, object in position to be drawn natural size; 9, mirror of ordinary camera lucida; 10, 11, camera lucida support; 12, light-tight roller-blind used, when unrolled as a diaphragm for the cone of light from the projector; 13, solar-projector set in special window casing near floor; 14, the negative being projected at 23; 15, 15, uprights carrying the adjustable sheet of glass on which the drawing 23 is being produced from the negative 14; 16, wooden frame for sheet of glass 18; 17, metal braces by which the frame 16 may be clamped at the required angle; 18, sheet of glass through which as well as through the paper 22, the image is viewed; 19, roller blinds to shut off extra light; 20, 21, sticks to which the drawing paper is attached with drawing tacks, these sticks being easily adjustable under the sand-paper-lined wooden springs-bars 24; 22, drawing paper; 23, image being drawn; 24, wooden bar lined with sandpaper and hinged at 25 and constantly pulled inward by a spiral spring at 26, so as to lightly but firmly grip the sticks 20, 21; 27, screw legs on which after the apparatus has been adjusted it can be raised so as to remain firm during the subsequent operations of focussing and drawing; 28, one of the four castors on which the whole apparatus is adjustable back and forward on the floor to vary the magnication.

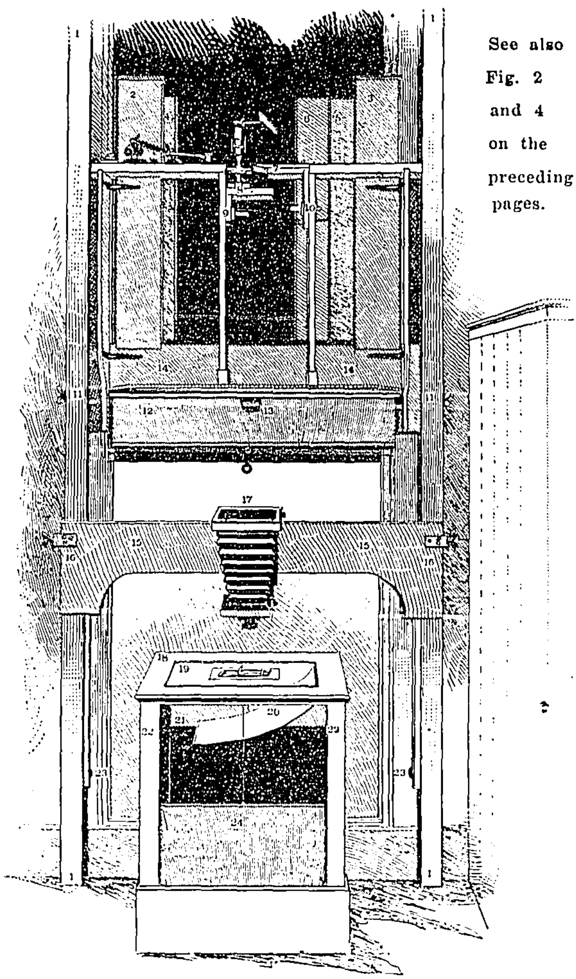
room. It is more necessary to give the details of the screen upon which the projection is received and upon the surface of which the artist produces his drawing. This screen is borne between two uprights about seven feet high, set on four castors placed sufficiently far apart to give the apparatus a firm support. After the apparatus has been rolled into position, four screw-legs are screwed downward and the apparatus is thus raised off its castors and placed on four legs, and is then sufficiently firm to resist all the pressure that is brought to bear upon it. The screen proper is pivoted between the two tall uprights, and by means of a series of notches is adjustable in the vertical direction. The screen consists, to all intents and purposes, of a very large glazed window sash having the glass flush with the framework. The sides of this sash or frame are sufficiently strong to give it firmness, and when the necessary angle is secured, a pair of clamps secures the screen from any mal-adjustment. At each end of the screen, two long pieces are hinged in such a way as to facilitate the manipulation of the paper upon which the artist works. These long narrow pieces are four feet long and one inch square and are hinged at the top of the screen and pass downward everywhere equidistant from the side of the frame, this distance being about three-fourths of an inch. At the lower end, these pieces are constantly pulled inward or toward the glass, by spiral springs. The under surface of each of these long pieces is lined with sand-paper. If now a long soft wooden stick suitable for the attachment of drawing paper be placed across the glass face of the screen, which as before remarked is flush with the frame, and be passed under the sand-paper surfaces, these latter will grip it with great firmness, and it will be found impossible to move it without the use of considerable force. It is to the under surface of this transverse piece thus held in position by the sand-paper surfaces at the ends of the screen that the drawing paper is attached by means of ordinary thumb tacks. This provision is advisable, as in the use of the projector it is often necessary to bring the drawing into register, or to change the register somewhat. By slightly lifting the sand-paper surfaces, the paper is easily changed in position to accommodate any change of register. It is usual to make two punctures on the negative as register marks. As it is anticipated that this apparatus will come into much wider use, it may not be out of place to mention a number of points which experience has shown to be worthy of imitation or improvement. The light is usually a very strong one and in consequence the operator is most strongly illuminated. It is therefore desirable that he should wear dark-colored clothing, otherwise the reflections from his person will cause considerable interference. It is also desirable to have the room as dark as it can be conveniently made—the darker the better, especially when high power magnifications are in progress. When the finest detail is to be drawn, it is also advisable to arrange at the top of the screen a roller blind carrying an absolutely opaque blind with an aperture not much larger than will give freedom of movement to the hand in drawing, say from four to eight inches across. This shuts out all of the extra illumination and the eye will then accommodate itself in such a manner that any fine detail is much more readily seen. It is also desirable to have a drop blind by which the whole of the light may be instantly shut off, as well as a light at the back which can be also instantly let on so as to give the operator a very distinct notion of what he is producing. For it must be pointed out that when the drawing is being made, it is not easy for the operator to see his work, especially if he is working with a blue pencil, as is often the case if the drawing is to be afterwards finished up, photographed, and reduced for illustration purposes.

The illustration room is also furnished with an ordinary camera working on vertical uprights of the same character as those already described in connection with the microscope window. These are a second pair of steel girders imbedded in cement below the building and coming through the floor without contact. It is found that a great variety of objects are more conveniently photographed by using the camera in this manner than in any other, though of course it is necessary for many classes of objects to use it in the usual way. To facilitate the production of the necessary backgrounds, a well is provided. This consists of an approximately cubical box, the sides of which are merely grooved framework in which run a set of opaque roller blinds. When these blinds are all drawn up, they make a box with a black interior, the roller blinds being painted black inside. The top of the well consists of a series of concentric frames capable of carrying plain and ground glass of various sizes. When it is necessary to photograph an object against a black background, it is customary to lay it upon a piece of plain glass, when the background, which consists of a black hole far beyond the focus, namely the interior of the dark-well, gives an absolutely black background which is obtainable in no other way. If it is necessary to secure grey backgrounds, a ground glass is substituted for the plain glass and one of the roller blinds is lowered and a mirror or other reflecting surface placed in the box below.

NATURAL SIZE DRAWINGS DIRECT.

Another peculiar feature of the illustrator's room is a piece of apparatus designed for the production of natural-size or even reduced drawings with the aid of the camera lucida.

Fig. 3. Drawing to illustrate the use of the ordinary camera riding on a vertical system. The camera lucida frame is pushed up out of the way, its details being, however, here shown in a somewhat different manner from that illustrated in Fig. 4. 1, 1, 1, 1, vertical girders imbedded in cement under the building and coming up through the floor without contact; 2, right hand box containing a variety of roller blinds working in a horizontal direction and so tinted as to give a great variety of transmitted light; 3, similar right hand box of roller blinds; 4, 5, 6, roller blinds; 7, drawing board horizontally and vertically adjustable, and also tipping to pass platform 8; 8, vertically adjustable platform for the support of object to be drawn, in this case supported on a microscope stage; 9, 10, clamps for securing 7 and 8 in position; 11, 11, screws for clamping all the previously described apparatus to the steel girders 1, 1, 1, 1,; 12, roller blind used as a diaphragm as described in the description of Fig. 2; 13, diaphragm aperture in the roller blind 12; 14, lower portion of the framework of the apparatus supporting 2-13; 15, 15, cross-piece carrying the ordinary camera 17; 16, 16, screw clamps for securing the camera after adjustment; 17, ordinary camera; 18, dark-well for securing black or other background for objects; 19, one of the various adapters for varying the aperture in the top of the dark well; 20, inner roller blind being used to secure a light background for the object being photographed; 21, one of the four roller blinds blackened inside and forming, when pulled up, the black inside surface of the dark well; 22, 22, vertical slots in which the roller blinds 21, 24, &c., slide in a light-tight manner; 23, anti-friction bearings of the framework of the cross-piece 15; 24, one of the four blinds forming the sides of the dark well.



See also Fig. 2 and 4 on the preceding pages.

CAMERA LUCIDA FOR NATURAL SIZE OR REDUCED DRAWING.

Ever since the introduction of the camera lucida, it has been more or less used for the production of natural size and reduced drawings; in other words, it was soon seen that its application went beyond the instrument for which it was primarily designed. The writer has used the camera lucida to a greater or less extent in this manner for twenty-five years and has seen plenty of evidence that others have used it in the same way. At one time it was thought by certain manufacturers that the demand for an insrument specially designed for this class of work would justify the making and advertising of the instruments; but so far as I am aware, all this apparatus has been now withdrawn from the market. I do not know what the reason for this course may have been. It would seem that the instrument met a scientific need and that its sale should have been sufficient to keep it from oblivion. The only conclusion one can arrive at is that for some reason, the form of the instrument did not meet the need. The following notes relate to a piece of apparatus which has been gradually developed during several years, and which has as its object the application of the ordinary microscope camera lucida to the purposes we have mentioned. It is a piece of apparatus which in use is placed in front of a window, in fact is usually attached either to the window, the window casing, or to special uprights near by. As exemplified in this laboratory, the apparatus is attached to two upright girders, the same two that carry the ordinary photographic camera. Both these attachments are slung on sash weights and can be moved up and down, so that either may be brought into play while the other is raised out of the way. The camera lucida attachment consists of two distinct frames which are separated near the middle of the window by a distance of eight to ten inches. The left hand frame is designed mainly to support the camera lucida, the right hand frame to support the drawing board. Both frames carry adjustable brackets and each bracket carries a horizontal shelf. The left hand frame therefore has a horizontal shelf carrying the microscope and this shelf is adjustable in the vertical direction, and can be clamped in any desired position. In a similar manner, the right hand frame carries a horizontal shelf, or drawing board, also adjustable in the vertical direction. The drawing board presents the peculiarity of being also adjustable in the horizontal direction, and of rotating about a horizontal axis so as to pass the opposite shelf,—it is required sometimes above that shelf and sometimes below it. The size of the apparatus is determined by that of the human body. The greatest distance that can be comfortably reached by an ordinary artist for drawing purposes is about thirty inches, i. e., when gazing through the camera lucida he can not comfortably produce a drawing at a distance of more than thirty inches from his eye as the light travels. An examination of the adjacent illustration will make this matter somewhat clearer. The camera lucida is usually carried on a piece of tubing clamped to an ordinary lens holder or empty microscope barrel. The object to be drawn is placed below, without a lens, or with a reducing lens, or in some cases with a lens which slightly enlarges the object. The drawing board is then lowered or raised until the drawing to be made will have the necessary size. It will be observed therefore that the whole arrangement is a three-fold one. There is a support for the object, a support for the camera, and a support for the drawing board, and these must be adjustable within the limits of the artist's reach. It will be seen, however, that if two of these are adjustable, the whole system is, for all practical purposes, the same as if all three were adjustable. We now come to the most important matter in connection with the use of this apparatus, namely: the illumination of the object and the illumination of the drawing board. It is possible that it is in this respect that the apparatus hitherto put on the market fails to meet the requirements of the case. It is very desirable to fully control the illumination. Sometimes the object has to be strongly illuminated, and the drawing board weakly illuminated, sometimes the reverse is the case, the object has to be weakly illuminated while the drawing board has to be very strongly illuminated, and the variation in illumination should be as great as possible,—from strong sunlight to absolute darkness, if posisible. This is the main point in the sucessful use of the camera lucida for this class of work. This object is attained in the present piece of apparatus by placing the whole at a sunny window and modifying the light by a series of seven roller blinds. One of these, and one of the most important, is the blind attached to the window itself. This does not differ from those elsewhere described in this report. The other blinds for this piece of apparatus have the peculiarity of working in the horizontal direction, the rollers being placed vertically side by side and enclosed in a light-tight box at the side of the window. The box on the right carries three of these rollers and that on the left carries a corresponding set of three. These blinds are of varying nature. One of each set is white, another is nearly translucent and a third is somewhat opaque. By placing these blinds one over the other, that is by adjusting them properly in the horizontal direction, the light may be varied in any degree required. No way has yet been found by which the light both upon the object and upon the drawing board can be fully controlled by foot-power, as in the case of the microscope window previously described; but it is believed that if sufficient thought were given to the subject, such a device might be evolved. In the meantime, the present arrangement works fairly satisfac-

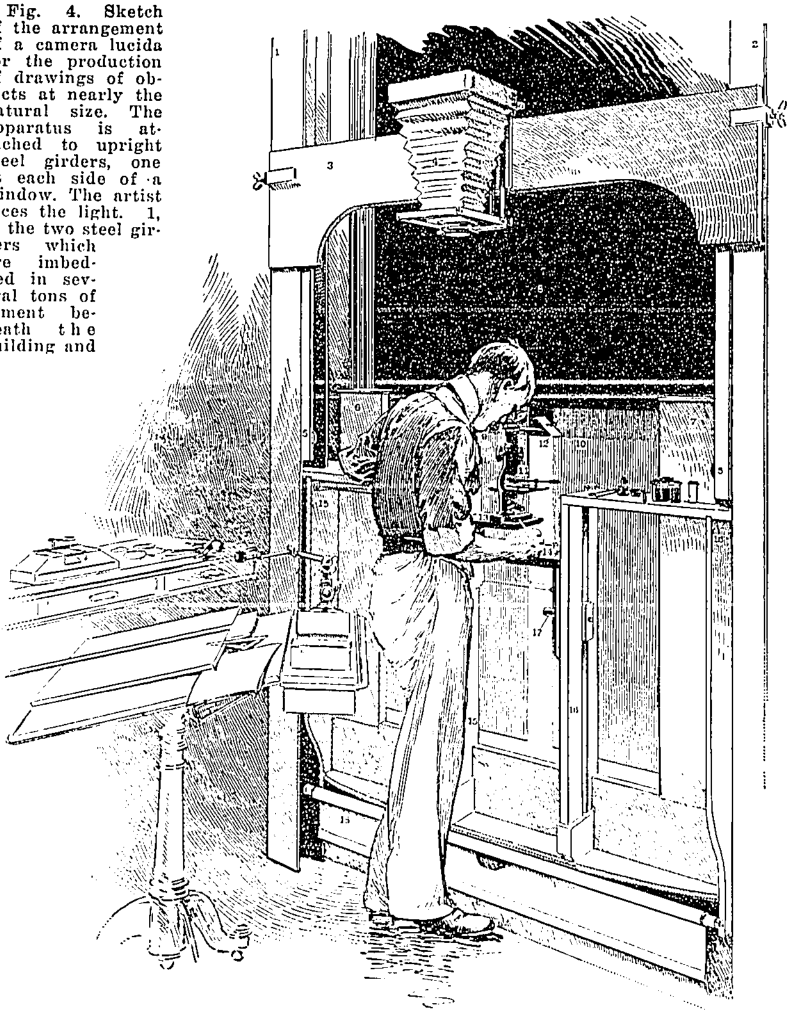


Fig. 4. Sketch of the arrangement of a camera lucida for the production of drawings of objects at nearly the natural size. The apparatus is attached to upright steel girders, one at each side of a window. The artist faces the light. 1, 2, the two steel girders which are imbedded in several tons of cement beneath the building and pass through the floor without contact; 3, cross-piece to carry an ordinary camera (4), this cross-piece being hung on sash weights and sliding in the vertical direction and readily clamped by the side screws shown; 4, ordinary camera pushed up out of the way but easily brought into use as shown in Fig. 4; 5, anti-friction arms of the cross-piece (3) which roll against the edges of the girders 1, 2; 6, left hand box of roller blinds; 7, right hand box of roller blinds; 8, light-tight vertically acting rollerblind of the window; 9, 10, horizontally acting roller blinds from the boxes 6, 7: 11, object to be drawn, held in stage forceps; 12, mirror of ordinary camera lucida; 13, horizontal stage, adjustable in the vertical direction, designed to support the object 11, which in this case is supported on the stage of a microscope carrying no objective or eyepiece; 14, horizontal stage, adjustable in the vertical direction, designed to support the drawing board, which tips out to pass 13, and is also adjustable in the horizontal direction. 15, 16, framework supporting all the apparatus 6-14 and slung on sash weights so as to be easily pushed up out of the way when the window is used for other purposes; 17, screw clamp to stage 14; 18, roller blind acting as a light trap and diaphragm when the window is used with the solar projector as shown in Fig. 2.

torily and avoids the use of complicated apparatus between the eye and what it is looking at, in the same way as does the apparatus previously described in connection with the microscope window.

A LIBERAL REDUCTION OF ORIGINAL DRAWINGS.

A study of the published work of the best modern artists gives ample proof that their originals are considerably reduced for purposes of publication. From the examination of the published illustrations it is difficult to give an estimate of the amount of reduction that takes place in the process of photographing the original, but a somewhat extensive and careful study of the best modern magazine illustrations leads to the conclusion that in many cases the reduction is a liberal one. Judging from the texture of the drawing as shown in enlarged projections, it is probably not far from correct to say that the reduction varies from one-half to two or three times, i. e., the areas of the published illustrations are from one-fourth to one-ninth that of the original drawings.

It seems doubtful whether artists have yet fully appreciated the advance that has been made in the art of etching on metal, and also doubtful whether we are not laboring too much under the influence of the former styles of reproduction. Without intending any disparagement to the high class illustration work of the past, I venture to call attention to the probable gain to be obtained by taking greater advantage of the perfection of modern etching processes. The best etchers, supplemented by the best printers, are now able to produce on good book paper well-defined lines as narrow as one four-hundredth of an inch. This is far beyond the power of any artist's pen if the work he does is to come within commercial limits. While what is here said refers more particularly to scientific illustrations, it is believed it is not without its application throughout the range of black and white line work subject to reproduction by means of photography and etching. Speaking from the scientific point of view, many of the illustrations required are far beyond the reach of unaided vision of objects, to say nothing of the capacity of the artist, and we always resort to magnification in order to avoid this difficulty. Natural size illustrations are the best; reductions and enlargements are resorted to as a compromise with our methods of reproduction and publication. Any hint that will lead us to bring our illustrations nearer the truth and more nearly to the natural size should, therefore, be of value. Now, it is found that if original drawings are made on a large scale by means of various mechanical methods, some of which are described in the course of these pages, justness of proportion and accuracy in the formation of the lines are much increased. By taking advantage of high class modern etching it is possible to reduce these large original drawings and retain in the resulting comparatively small and therefore also comparatively inexpensive illustrations, all that justness of proportion and accuracy of line that is displayed in the large original. So far as the writer has exploited the matter, he believes that reductions to one-tenth and even one-twentieth linear are feasible, i. e., the blocks for publication will have only 1-100th to 1-400th the area of the original drawing.

What has hitherto been said introduces no practical difficulty. The modern mechanical processes will meet all the requirements that have been mentioned. There is, however, a rather serious difficulty connected with producing the original drawings. It is very difficult for an artist who has formed a style that meets the needs of former requirements to so alter it as to meet the exigencies of the liberal reductions that have just been mentioned. I find that the tendency of all artists who have been engaged upon my work is to do more work on these coarse originals, if I may so style them, than is necessary. The tendency is to make the work too fine, to do too much, the result being that the limits of the etcher are passed in certain respects, particularly in the width of the white lines, so that the problem confronting the artist who attempts to work in the manner indicated is to learn a coarser style of work and to learn how much he can leave out. Once this art has been acquired, the rest is clear sailing and the gain in the published illustration may be briefly summarized by saying that it is nearer the natural size, i. e., the ideal size; second, its lines are brought nearer the limit of modern processes, in other words, are finer where it is necessary that they should be finer; of course nothing is here for a moment urged against the use of coarse lines wherever they are appropriate; thirdly, the drawing gains in the important point of scientific accuracy; fourthly, there is a greater range in width of line.

EXPERIMENT FIELD.

At the Experiment Field a number of experiments have been started, having for their primary object a physiological and pathological study of the cuttings of cane and their germination.

These experiments are of a preliminary nature, and it is not expected that many of them will do more than point out the best method of procedure for next year. The plantings were unavoidably late, and many of the conditions surrounding the experiments were such as to preclude anything more than making a beginning this present year; but it may be well to outline some of the objects of the different experiments.

The extent to which cane cuttings may be injured by lengthy soaking in Bordeaux mixture, has been tested in a preliminary way. The strength of Bordeaux that cane cuttings will bear has been the subject of another small experiment. The relative germination of cuttings showing a definite number of diseased fibres has been tested in another small experiment. Cuttings have been prepared in different ways with the object of ascertaining whence the bud derives the greater portion of what may be called its internal nourishment. The effect of lime on cane cuttings has also been the subject of experiment. A number of other experiments are in progress, and a plan of work for next season is being most carefully elaborated. It is thought that a careful study of the whole subject of the early history of the planted cuttings will yield results that may prove of considerable importance.

Respectfully submitted,

N. A. COBB,

Director Division of Pathology and Physiology.

Honolulu, October 24th, 1905.

Dr. N. A. Cobb (Director of the Division of Pathology and Physiology)—Mr. Chairman, and Gentlemen: Being called upon at this time to present an annual report, reminds me of the question of the boy as to the possibilities of making a two-year-old calf in a minute; as the Division has been in existence only a few months, it is rather a misnomer to term our contributions to this report an "annual" report.

The report which I have submitted is rather technical in nature, and is more adapted to other purposes than to the entertainment of a meeting of this character. It relates particularly to the equipment of the buildings and rooms which house the Division of Pathology and Physiology. My reason for throwing the report into this form was two-fold; first of all, the apparatus is more or less unique, and I wished to have on the premises a full description of the uses to which it could be put for future reference. I was all the more impressed with the advisabilty of doing this, because, on leavin a former position, one of the difficulties that arose was the fact that the apparatus left was not sufficiently well understood by those in whose charge it would be in the future. Secondly, we depend very much at an Experiment Station of this character upon our exchanges. We receive from other Experiment Stations—from co-workers in similar lines—very valuable reports, and I felt that some description of this apparatus might be of some little interest to Experiment Station workers everywhere. Now of course we contribute to other Experiment Stations mainly the material dealing solely with sugar cane, but the stations to whom these bulletins on the subject of cane are of paramount interest are comparatively few. The number of Experiment Stations in the world is quite large, some eight hundred, I think. The other stations do work that is very useful to us, and it is very desirable that we should as soon as possible, establish a copious exchange, and it happens that this report,—printed in separate form as it will be—can be utilized as an exchange among those stations which would find comparatively little to interest them in the reports upon cane, because they have never had to do with the raising of that crop. I think these few words of explanation are nearly all that is necessary in connection with my so-called report.

I understand that you are invited to visit the Experiment Station on Thursday, and on that occasion you will have ample opportunity to see all this apparatus and, if it is of any interest to you, to make such inquiries and observations as you may desire. I might add that at each mill I presume there exists in most cases a man who has charge of a microscope. It might not be out of the way to call the attention of this officer to the facts which are here reported as he may possibly derive therefrom some suggestion as to the use of the microscope.

The ideas in regard to the production of illustrations for our Bulletins will be far more interesting, I fancy, to members of the press, if any are here, than to the Planters' Association. They are of such a character that they are at once applicable to the exigencies of producing illustrations for either a daily, weekly or monthly newspaper, and they are, in fact, now adopted in a number of printing establishments.

With regard to the experiment field which is pictured in the report, I would like to say that I do not consider it is worthy of very much attention on your part at the present time. I should be very glad to accompany any visitor to it who desires to see it, but would like to say here and now, in order to prevent unnecessary labor or any disappointment, that the results that have been obtained are not yet sufficiently advanced to be worthy of any great attention on your part. The experiments are conducted on lines that are explained briefly in the report of the Committee.

This afternoon I shall have occasion to address you at greater length, and shall have the room well hung with charts for the purpose of explaining the different points that will be raised in the address, and Mr. Lewton-Brain, the Assistant Director will also address you at the same time; so that I think I need not take more of your time in connection with this report, except to call a little closer attention to the program which is inserted in the report of the Chairman of the Experiment Station Committee.

I would like to say with regard to some of the items there, for your information, that the investigations in hand relate to Root Disease, the subject upon which Mr. Lewton-Brain will address you this afternoon; also to several other diseases, notably the Rind Disease, and the Pineapple Disease, as well as certain Leaf Diseases which may or may not prove to be comparable in importance with the three diseases which I have already mentioned.

Experiments are also in progress in connection with the treatment of cane-cuttings with different fungicides. As you are probably aware, the first bulletin of the Division dealt with that subject, and it was there intimated that experiments would be conducted in connection with this subject, with the object of ascertaining what are the best methods of treating cane cuttings either with Bordeaux Mixture or other suitable fungicides.

These experiments have been undertaken, and although the results are not yet to hand, we are well advanced in that direction and are able to say some things already with regard to the strength of Bordeaux Mixture that can be used on cane cuttings, the length of time to which we can submit the cuttings to the mixture with impunity, and whether or not different varieties of cane are affected differently, whether the tops are more sensitive to these solutions then the portions of the cane lower down, etc., etc.

I think I have covered all of those points in the report that it would be desirable to allude to at the present time.

(The report of the Director of the Division of Pathology and Physiology referred to in the remarks just above, are published in the Year Book as Appendix 3).

The President thereupon called the attention of the Association to the possible danger of introducing insects which might be beneficial in certain directions and accomplish certain objects, but which might become injurious otherwise, and thought that it would be well not to overlook the importance of being on guard against any such occurrence. Professor Perkins, Director of the Division of Entomology, in response to the remarks of the Chairman, then stated that it was impossible to tell what danger any insect was doing to any particular plant unless specimens were examined; also that as a general rule an insect which feeds upon carnivorous food would not change from that kind of diet to vegetarian; that the entomologists always exercised extreme care not to introduce insects, which would ever be likely to become injurious; that, as far as the insects under discussion were concerned, inasmuch as no specimens had been handed into the Division for identification, he would be unable to make any definite statement about them.

AN ADDRESS ON THE DISEASES OF PLANTS, ESPECIALLY AS RELATED TO SUGAR CANE.

By Dr. N. A. Cobb.

A hardworking friend of mine once found himself in a state of health that gave his family and friends considerable anxiety, and through their solicitations he consulted a great physician.

My friend is a well-known man, and the doctor gave him a special appointment early one morning when both could command freedom for a long consultation.

The symptoms were recounted, and all the doctor's questions answered. Then came the examination, systematic and thorough, of every accessible organ. Heart, lungs, abdomen, nervous reactions, eyes, etc., were each the subject of close scrutiny.

The examination over the doctor said, "Well, sir, you have no organic disease. From what you have told me and from what I know of you by reputation I must conclude that you are suffering from the results of a course you have voluntarily adopted. You have become so absorbed in your various pursuits that you have neglected yourself. You have been workiny beyond your capacity, and in order to gain time for business you have been hurrying at meals, and in general adoption strenuous methods, until those interested in your welfare are becoming alarmed at the results. The remedy is entirely in your own hands. Medicine would be worse than wasted on you. There is no drug you can take that would not make you worse.

As I said in the first place you are in the condition of very many people who consult a physician,. Their symptoms are simply the result of,—well, indiscretion, to put it plainly. When they are suffering from actual disease it has usually resulted from the accumulated effects of drugs. Very commonly they have become poisoned through the imperfect consumption of overdoses of food or drink, and have then treated the resulting symptoms with drugs until they have at last succeeded in breaking down the barriers that nature has erected in every man's body for the resistance of disease, and they have then actually become diseased.

If they have contracted typhoid fever, it is because they have by their own indiscreet courses so weakened the action of the stomach that the microbes of the disease were not killed on entering the body, as they should have been. If they have contracted some grevious skin diseases it is for a similar reason, namely that they have by their own indiscretions so weakened the natural resistant qualities of the skin that it has been overcome by the organism causing the disease.

I can give you no medicine that will help you. I can only give you advice. If you follow my advice these symptoms will disappear. If you do not, you may go on for some years yet, but sooner or later you will break down prematurely."

Then followed some plain advice as to careful mastication of moderate quantities of simple food, abundance of the purest air possible, plenty of bodily exercise daily, avoidance of disputations and worry, and taking time to enjoy his family and friends,—of the soundness of which it is not too much to say my friend was as well convinced beforehand as the doctor. The point is that he was now sharply reminded that he had been neglecting to do things he was perfectly well aware he ought to have done.

I more than suspect that in the matter of crop diseases we might advantageously take to heart some such commonplace sound advice as that of which I have just recounted so striking an instance. And it is somewhat on these lines that I shall address you today.

As this may be the only opportunity that I shall ever have to address the cane planters of Hawaii, I have been all the more willing to embrace it, and I have naturally chosen a subject connected with the work of the Division of Pathology and Physiology in order that your program might be rounded out to cover all the various activities of your Experiment Station.

Having been born on a farm and having in my younger days followed farming for some years as a vocation, it was not unnatural that after having been first trained as a chemist and—then as a biologist I should have given a considerable portion of my time to the study of the maladies of cultivated plants. I propose in my address to draw upon the experience thus gained and place before you certain ideas that in my opinion must be your guides in all your attempts to cope with the plant diseases that are now present in your Territory, or are likely to arrive here.

At the outset let me say that I have no measures to propose than can effect an immediate and perfect cure,—no captivating scheme by which it is proposed to banish all your troubles, —no cure-all to propose. The medical profession has a word which it applies to the propounders of such schemes. There are few words in the language more heavily laden with derision and contempt than the word "quack."

Let our attempt be rather to carefully review the case before us, and apply to every feature of it all the knowledge we can bring to bear with the special object of making the cane industry more profitable.

When I look over my list of topics, I confess that I am apprehensive that to do all this in a single lecture is well nigh impossible. The best that can be done is to proceed as far as possible in the direction indicated and leave to the future whatever cannot be accomplished this afternoon.

It is a well-tried maxim in technical discourses to assume that your audience is not so well versed in the fundamental principles of the subject that a brief review of them is out of place. Accordingly I shall dwell at some little length on certain biological facts that constitute the foundation of all the measures that may be utilised in the combatting of the diseases of cane-crops.

If it were necessary to do so I am sure that I could arouse your interest in a lecture of any length by reference to the economic importance of the subject.

If we search historical records for instances of crop losses in various parts of the world, we find them scattered through the entire history of agriculture. References to losses that must be attributed to fungus pests occur in the Bible. In more recent times the statistician has given us figures that convey in the fewest words the actual losses in a few special cases.

The potato famine in Ireland was caused by the attacks of a well-known fungus disease of the potato. The losses must have reached many millions of dollars in a single year, to say nothing of the dreadful loss of life following on the failure of one of the principal foods of the people.

The coffee industry was nearly annihilated in Ceylon through the attacks of fungus pests. During sixteen years it is estimated that the annual losses averaged five million dollars yearly. At the end of this time the industry was practically extinct.

In India the annual losses due to a single crop disease, the rust of wheat, varies from two to ten million dollars.

In Australia in the year 1890-91 the losses from a similar disease of wheat were estimated at over twelve million dollars.

The losses from the crops of the three principal cereals of Prussia are estimated to total from fifty to one hundred million dollars annually.

Losses from vine diseases in California have been estimated at ten million dollars. These losses occurred in a comparatively short time.

It is estimated that the losses due to the attacks of insects in the United States total from two to three hundred million dollars per annum. The best judges place the losses due to fungi at no lower figure than those due to insects. At the present time the Department of Agriculture at Washington is engaged on a plant disease survey. I anticipate that this survey, which will be the result of careful compilation from most authoritative sources, will result in showing the losses due to the fungus diseases of crops to reach several hundred millions of dollars annually.

To come nearer home, it is well known to you that through the agency of diseases the cane crop in various parts of the world has been subject in recent years to losses which could be definitely estimated, and these have reached such serious proportions as to demand very special attention. It has not been infrequently the case that cane-growers in districts of various parts of the world have become so alarmed at the losses due to certain diseases as to begin to fear that their industry was doomed. In this connection I will only instance the Rind Disease in some of the West Indian Islands, the "Gumming" disease in certain portions of Australia, and that curse of cane-growing in Java, the disease called "Sereh." No better proof could be forthcoming with regard to your own feelings in this matter than the establishment here through the Planters' Association of a Special Division of the Experiment Station to deal with these diseases. All these arguments arise from definite instances where large losses have been sustained, but there is another loss perhaps equally great that commonly escapes attention.

Most of us understand human nature well enough to know that the incidence of an indirect tax is least resented by most people. Whether this is a good thing I have no intention of arguing; the fact is enough for my present purpose. Such a tax is submitted to the more readily because it is levied indirectly, a little here and a little there, in such an obscure manner that most people are unaware that they are paying it at all.

The small annual losses that are the result of incipient attacks of fungus diseases may be compared to a tax levied in an indirect manner. If aware of them at all, we have come to look upon these losses as necessary and inevitable. When taken altogether they constitute a real drain on the agricultural production of all countries. If they could be stopped we should at once have a succession of years of plenty, if not an actual glut.

Should your interest be aroused by these statistics, taken rather at random, it will certainly be further stimulated if it can be said that there is a definite prospect that these losses can be diminished. Experience has proved that such is the case. In fact one of the most remarkable of the changes in recent agricultural practice is the changed attitude of the farmer toward fungus diseases. It is within the last twenty-five years that the changes to which I refer have taken place. In the growing of fruit and vegetables an outfit is now hardly regarded as complete that does not include special machinery for the fighting of fungus pests. The saving thus effected adds very materially to the profits of these industries.

Suppose it to be possible to increase the cane crop of Hawaii by so much as four per cent. by taking special measures against fungus diseases of cane, we should than effect a saving of one million dollars annually. I believe such a saving is easily possible. Should this prove true you will be justified in an annual expenditure of some forty thousand dollars until the measures are in full operation, when it should be possible to continue them at a smaller cost. In making this estimate I am reckoning that money can be had at four per cent., and that the saving on the entire crop of the Territory is one million dollars per annum as compared with the present average yield. In adopting these figures as the basis of my estimate I feel that I am within safe limits.

Another way of showing the importance of the subject is to carefully consider what agriculture really is. In my opinion the term agriculture is not an altogether happy one. I fear the use of that word has done something towards the perpetuation of a serious error. The word points to the soil as it that were the principal element in the growth of crops. The word means the cultivation of the fields, while the fact is it is the plants that are cultivated. Agriculture is a word that seems to indicate that the soil is the most important thing in the growth of crops. The fact is that plants are the most important thing. The soil is no more the main thing in agriculture than the bed of a stream is its principal feature. The moving stream of water is the principal thing. It is the water that can furnish power and float ships; it is the water that can vivify the desert. The field or the soil bears some such relation to the stream of living crops that flow through it year after year, as the bed of a river bears to the water streaming through it.

This is by no means a barren idea. Our progress in agriculture will bear some ratio to the firmness with which we lay hold of this idea that the plants are after all the main thing in the growing of crops.

If the plant is the main element in crop production we must take the greatest pains to understand the plant. We must understand its anatomy and its physiology and its pathology. Agriculture is the art of rearing healthy vigorous plants, and so considered may even be regarded as an application of the facts of plant physiology and pathology.

It was not without some little discussion that the new Division recently added to your Experiment Station was called the Division of Pathology and Physiology. One could have the very greatest sympathy with the desire to get at these fungus diseases that are causing such serious losses, and as it has been customary to call the experts in this line of work "plant pathologists" it is no wonder that it was sought to found a Division of Pathology pure and simple. I think a little thought will show the inadvisability of such a narrow field for the new Division.

If one of your engines breaks down you would never think of employing for its repair a man who did not understand the interaction of the parts of an engine in good running order. He would in fact be about the last man you would think of employing for that purpose. What you want on such an occasion is an engineer, one who fully understands all the parts of an eigne, and how they best go together in order that the machine may work properly. If he does not know when the machine is working properly he is most certainly incompetent to repaid it when it breaks down.

The cane plant is a machine,—a machine a thousand times more intricate and difficult to understand than an engine. The pathologist that undertakes to advise concerning its condition when it breaks down from the attacks of disease will be competent in proportion as he understands the interaction of the parts and forces that constitute a healthy cane plant. That is to say, in proportion as he understands the anatomy and physiology of the cane plant.

This seems fairly plain but it by no means states the whole case, for it is a fact that not only is the physiology of plants very imperfectly understood as yet, but in particular that of cane stands behind that of some other plants, notably those of the temperate regions where the cultivation of science has hitherto been most active.

From this you will see that the study of the healthy cane-plant must constitute no mean part of the work of any institution that attempts to deal rationally with the diseases of cane. No matter what it may be called, to be efficient it must be an institution for the study of both physiology and pathology.

Of course the subject that we have met to consider is not one that can be mastered in an afternoon. The most that can be done is to take up a few principal topics, deal with them briefly and in this way sketch as completely as may be an outline of the existing condition of affairs and the plans which may be adopted for their improvement.

Cane being a plant which has been long an object of culture has been brought to such a state that it is now liable to diseases to which it would be little subject in its wild state. Moreover it is a plant which grows only in tropical or sub-tropical regions, where the various enemies of crops flourish in unusual numbers. Hence we find the crop we have met to consider is subject to diseases of all kinds. Fungi of every class attack it. Some of its diseases are caused by microbes at the lower end of the fungoid scale and others are caused by the attacks of mushrooms or toadstools at the other and higher end of the scale. Furthermore, every part of the plant is attacked. It has diseases of the root, diseases of the stem, diseases of the leaf and even special diseases of the blossom. It is, of course, impossible today to go carefully into the anatomy of the cane plant. It is eually impossible to study into the anatomy of all the various organisms which attack the plant in such a manner as to cause disease. Time would not permit. It would be impossible for any plantation manager, busy as he is with many other matters, to give that attention to these subjects which would make him a competent pathologist, but I am glad to say that without a complete knowledge either of the anatomy of the cane plant or of the facts of pathology, it is possible to attain to such a state of knowledge of our subject as will be extremely useful and profitable to any one engaged in growing cane. In order, however, to reach this state, a considerable amount of close study is necessary, followed by close reasoning on the resulting observations. I can not leave this part of the subject without calling attention to two aids to this end, namely, the ordinary pocket lens, and the microscope. With regard to the first, I have no hesitation whatever in saying that every manager and every skilled employee should carry in his pocket a good hand-lens to enable him to make such observations as are absolutely necessary in order to attain to any very useful understanding of the subject. It is with more hesitation that I recommend a much more general use of the microscope. My ideas on this subject differ so radically from those of most of my contemporaries that I am rather diffident about presenting them. I will only briefly say that I am convinced that the microscope is a much neglected instrument,—that it should be in the hands of a hundred people where it is now in the hands of one: that it is an instrument that is too often regarded as a complicated mechanism of glass and brass that is of real use only in the hands of scientists and experts. Microscopes are now made for a comparatively small sum of money which are capable of furnishing in every family in the land information of very great value indeed at very small cost, conferring the benefit of direct observation in place of that hazy sort of knowledge, so-called, which comes from the perusal of the observations of others.

It is difficult to define the term "disease." If we consider all the possible stages of health from that of perfect health to that extreme condition which results in death, we shall find it very difficult indeed to say at what point health ceases and disease begins. Disease is produced by a variety of causes that act in such a way as to complicate the matter to a considerable extent. Any healthy organism is more or less subject to a variety of attacks, any of which may work injury. Some of these agencies are minute organisms which on gaining access to the living body of a higher animal or plant cause sickness and possibly death. In these cases we have no hesitation in saying that disease is present. On the other hand we have factors of a different kind which, though equally fatal, act in such a different manner that we never think of attributing their injuriousness to disease. Large numbers of the people of India are annually killed by tigers, but the onslaught of tigers does not constitute a disease. If, however, the size of the attacking organism be reduced you will see that we approach the limits of disease, as we ordinarily use that term. For instance, these same people, not to mention nearer ones, are sometimes attacked by lice. Now, lousiness might by a slight stretch be included within the meaning of the word "disease." If the size of the organism be again reduced somewhat, we bring the result of its attacks well within the limits of the word "disease." The itch is a well-known disease. It is caused by a mite visible to the naked eye and not very many sizes smaller than a louse. The object in running this gamut has been to bring out clearly the limits of what we call disease in order to show that plants really have diseases. We do not have to go back many years to reach a time when the idea of a plant having a disease was met with incredulity if not ridicule. The time is well within my own memory when those who proposed such ideas and ventured to suggest that a careful study of the subject might lead to results of great importance, were not infrequently dubbed "plant doctors," and the line of ridicule thus adopted, I have no doubt, did a good deal to retard progress in this direction. Those times, however, are past, and it is now recognized that plants suffer as much from diseases, strictly so-called, as do animals. They have their diseases caused by microbes. These are now daily being multiplied. New discoveries of this kind occur almost every month, and these microbes are by no means distant relations of some that cause diseases in animals. Plants are also subject to special diseases due to many other kinds of parasitic plants as well as parasitic animals.

These various diseases may be divided into two classes, those which are caused by the direct attacks of other organisms and those which primarily, at any rate, are the result of physical causes such as starvation or extremes of temperature. The Gumming Disease of the sugar cane, which is caused by a microbe, is an example of the first class; as an example of the second we might cite, perhaps with a good deal of force, the Root Disease of the cane, which more commonly follows those physical conditions of the cane which, it is plain to see, reduce its resisting power. In the study of any particular plant disease, the factors to be considered are three in number; (1) the plant that is attacked, (2) the attacking organism, and (3) the predisposing causes, that is, those causes which have so acted upon the diseased plant as to bring it into a condition such that the disease could get a foothold within its tissues. It follows, therefore, that in considering the diseases of cane we should understand, as far as is within our power, first, the structure of the cane-plant; second, the nature and structure of the organisms which attack it; third, the predisposing causes which reduce the cane plant to such a condition that the attacking organism succeeds in making a breach.

In order to give you some idea of the structure of a plant, I have placed here a diagram of a cell. If once we thoroughly understand the structure of a cell, we have gone a long way toward understanding the structure of a cane-plant, which is nothing but an aggregation of more or less similar cells. You will see that the diagram represents a rounded body consisting of an outer shell enclosing an inner structure of considerable complexity. The outer shell is commonly called the cell wall and is composed of a very familiar substance, cellulose, which is the main component of wood. The interior of the cell is of a very different nature, its most important part being termed "protoplasm," and the cellular organism which is made up of the protoplasm is commonly called a protoplast. The living plant cell usually presents these two elements, a living inside element, the protoplast, and an outside dead skeleton, the cell wall. The protoplast is composed of several different elements, notable among them being a more or less central element termed the nucleus. This nucleus is imbedded in granular matter which etends in young cells as a continuous mass as far as the inner surface of the wall of the cell, but in older cells extensd only through certain portions of the intracellular space in the shape of a network. In all instances, however, this granular matter lines the entire inner surface of the cell wall. It is hardly necessary for me to burden your memories with the names and properties of the different parts of the cell or at any rate with explanations of their intimate nature. A mere enumeration will serve the present purpose? I will therefore only say that this portion of the protoplasm outside the nucleus, is termed cytoplasm, while that part which resides inside the nucleus, as least for a greater part of the time, goes by the name of karyoplasm. The nucleus is the leading element in every cell. All the activities of the cell are apparently governed by and from the nucleus. If any portion of the wall has to be mended or strengthened the nucleus is observed to repair to that particular portion in order, as it appears, to direct the operations.

I have the good fortune to be able to show you a sample of this substance protoplasm in a living condition. I have here an organism, probably unfamiliar to most of you, known as a slime-mould. It is one of the most lowly of all organisms, and is so simple in its nature that its affinities have been the subject of much discussion among naturalists. By some it has been held to be a plant, by others an animal, by still others an intermediate form. At present the balance of opinion is, I believe, in favor of placing it among the animals, though some might perhaps dispute this. But whether we regard it as a plant-like animal or an animal-like plant, its structure remains the same. The form in which I show it to you consists, to all intents and purposes, of nearly naked protoplasm. It is in motion, though I doubt if you will be able to observe that fact in the time at your disposal. As a matter of fact it is slowly creeping over the surface of the damp soil on which it lies. In color and consistency it is entirely similar to the network of protoplasm pictured on these charts. As you regard it I would like you to have a realizing sense of its wonderful nature. Within wide realm this protoplasm is well nigh all-powerful. Its power for good or evil within those limits is almost boundless. It can move and multiply. It can seize on that which is dead and make it to live. On occasion it can create the maddest havoc. A few centuries ago some of it, taking on the form of the plague, issued from Asia and did not cease from its ravages until, in the course of three years, it had caused the death of 25,000,000 human beings in Europe alone. It is the only known abode of life on this planet. Whatever is alive is so by virtue of the properties of just such matter as you see here. It can move from place to place, if not by virtue of its own powers, then by harnessing other powers. It can see, feel, smell, taste, hear, and is endowed with other senses of some of which we probably have as yet formed no conception. It can think, talk, love, hate, kill. Anything a man can do it can do,—for a man himself is a manifestation of some of its various activities. Precisely how it came into eistence we do not know. That it goes on multiplying itself we can see. What it will finally succeed in doing no one can foretell.

I have said that the cane plant is an aggregation of cells. From this it follows, of course, that the growth of the plant consists in a multiplication of cells. I hold before you a single seed of cane. It is uite a small object, but small as it is, that portion of it which is destined to produce the future cane-plant is very much smaller still, so minute, in fact, that only a hand-lens can reveal it. This small object is itself the result of growth during the last few days from a single cell which existed in the cane blossom before its fertilization. The act of fertilization consisted in adding to this single cell which existed in the ovulary of the blossom, of a new nucleus derived from a grain of pollen. On the acquisition of this new nucleus, the single cell began its process of division It divided first into two cells, then into four, then into eight, and so on, and on planting the seed the process will continue until the number of cells rises to many millions joined together into the form which we know as a full-grown plant of cane. This process of multiplication is one concerning which it is well to have definite ideas.

The division of a cell commences, so far as we understand it at present, in the nucleus. The nucleus is composed of several different elements and these, though ordinarily arranged in what appears to us to be an irregular manner, on the advent of mytosis, as the process of cell division is called, become arranged in a systematic manner. Certain elements which are apparently of a uniform nature group themselves according to certain laws and go through certain processes which may aptly be compared to a dance. These elements pair themselves, pass and repass each other, come together and separate much as do the couples in a dance; in fact, the movements of a large hall filled with partners going through the evolutions of a quadrille do not present a more elaborate or more precise series of motions than those which take place within the bounds of every cell during the process of its division into two new cells. When the new nuclei have formed and separated from each other, the later processes of division take place, by means of which the nuclei divide up between them the cytoplasm of the original cell and each surrounds itself and its own portion of cytoplasm with a new cell wall. The operation which I have thus briefly sketched is in fact the essence of all growth. Growth consists in the multiplication of cells, and for the most part in this particular manner. Following this plan, a single cell constituting the egg of animal or plant ultimately becomes a full-grown individual of its particular species. I doubt if there is any spectacle more impressive than that afforded during the early growth of such an egg-cell.

Come into my laboratory at sunrise. We have on exhibition the most wonderful drama,—the drama of life. Between sunrise and sunset we might see the whole of it. Look through this microscope. Under it is placed an egg of microscopic size, and nearly as transparent as glass. Except in size, however, it does not differ very materially from any other kind of egg, and what is taking place in it will take place in a modified form in any egg. Between now and sunset this egg will have changed into a living being armed with all the organs necessary for the struggle for existence and the propagation of its kind, and we may witness the wonderful transformation at one sitting. It lies there round and motionless, a mass of granular matter enclosed in a glassy shell. Somewhat separated from each other, towards the middle of the egg, are two bodies darker and otherwise different from the remainder of the contents. The larger of these two seems to be slowly rolling its contents about, struggling with itself, as it were. Finally, a small part of it separates and moves toward the outside of the egg, followed soon by another similar part. Now the two principal characters in the drama, these two darker granular bodies—the hero and the heroine, as it were, the larger being derived from one parent and the smaller from the other—begin to enact the scene that has been watched and studied with the most intense interest by biologists in all parts of the world.

Approaching each other they unite. There is thus formed the first element of an embryo, a single cell—that is to say, a sack-like membrane enclosing protoplasm and a combination nucleus. By these changes the general appearance of the egg is not much altered. Soon, however, the nucleus begins to exhibit peculiar movements as if struggling with itself. Slowly it generates two poles, which, separating from each other, draw the nucleus into the form of a spindle, near the middle of which peculiar V-shaped bodies, now split longitudinally, again arrange themselves. Suddenly the spindle falls asunder, the two halves contract, each into a separate nucleus. Simultaneously with these latter movements the two halves of the egg clothe themselves with a membrance. The egg is now in two parts,—the descendants of the former one part. Each of these divides and produces descendants of its own, and in a few hours the contents of the egg by this process become converted into 4, 8, 16, 32, 64 cells or balls. These gather into a form well represented by a rubber ball with one side pressed well in. The edges of this figure approach each other, join, fuse together, and form a tube closed at both ends. The tube elongates, forms a mouth at one end and a vent at the other. Soon it begins to move visibly after the manner of a living animal. As it elongates more and more we see that it is a worm. Organ after organ grows before our very eyes, the movements grow more and more active, until at last the egg-shell bursts, and the young worm springs out and swims away to join its fellows. This is the well-known story of the growth of the animal embryo. What makes these phenomena of absorbing interest is the fact that it is now proved that the two primary nuclei, male and female, each contribute a part of their substance to the nucleus of the primary blastomere which forms the first rudiment of the embryo. We have thus at last obtained a firm hold of the important subject of heredity. In consequence the outlook in this direction is full of interesting possibilities. These parts contributed by nuclei of the two parent cells, and now proved to pass into the nucleus of the primary blastomeres, must be followed into the secondaries, and so on through the history of the individual. This will give us a science of heredity, and lead us to a scientific knowledge of the origin of mental and physical traits, among other things the origin of sex. Meanwhile we are sure of rational theories of heredity to stimulate further discussion and discovery.

The cells of various plants differ from each other in the presence or absence of green coloring matter. Nearly all the plants upon which we rely for the production of crops are plants whose cells contain green coloring matter. Nearly all the plants that attack crops are such as have cells containing no green coloring matter. The presence or absence of this green coloring matter constitutes such an essential difference in the two classes of cells or plants that I wish to dwell upon it at some length. All those plants which contain green coloring matter in their cells have the power of converting the carbon that exists in the atmosphere into starch, sugar and other products, and thus furnishing the plant with nourishment. This change of the carbonic acid gas of the atmosphere into carbo-hydrates takes place under the influence of sunlight, and it is this fact that causes the upright habit of most plants.

The upright habit has been acquired simply in reaching up after air and sunlight. The fungi are composed of cells destitute of green coloring matter. It appears that they have lost this coloring matter through adopting a parasitic habit of life. Their nearest allies among the green plants are found among the Algae and it is believed that they are descendants of green plants of that group. Through their parasitic tendency they have lost their green coloring matter, or, to put it better, they have lost the faculty of utilizing sunlight as a source of energy. They can grow in dark places where ordinary green plants could not thrive on account of the absence of sunlight. But to atone for the loss of this green coloring matter, they have acquired the habit of abstracting organic matter from other sources. They can not themselves absorb inorganic matter and convert it into organic matter as can the green plants. They must have their food already more or less organized, and they may be divided into two groups, one of which requires its food not only organic in nature, but actually living, and the other of which can thrive on organic matter although it is dead. Those which require living organic matter as a substance upon which to feed are the true parasites; those which can utilize decayed organic matter are termed saprophytes. Needless to say all stages can be found between truly saprophytic and truly parasitic fungi. There are parasites which can on occasion live, if not thrive, on dead organic matter. There are saprophytes that on occasion attack living organisms. There are intermediate forms which seem to be more or less indifferent, thriving upon either sort of food. With this brief outline of the nature of green plants and non-green plants, we are ready to consider the struggle which takes place between them for the mastery, and this struggle is one that may be aptly termed a war. The struggle is as keen and the implements and materials of war are almost as numerous and complicated as in the case of two contending armies. The defences set up at Port Arthur are not more elaborate or, in their sphere, more effective than the defences which are set up by every green cell. The instruments of war brought to bear upon Port Arthur for its destruction and the tactics adopted for that end were not more varied nor complicated than those which every fungus brings to bear upon the defences of a green cell. We have these two contending parties arrayed against each other, the whites and the greens, the greens always conducting a defensive warfare, while the whites act on the offensive. The greens surround themselves by defensive walls. These walls are of varying character according to the prospect of outward attack. Those green cells which are least liable to attack are furnished with the thinnest walls; those which are most liable to attack are furnished with the thickest walls. The defence, however, is not a mere matter of thickness, any more than the thickness of the walls of Port Arthur constituted the single element in its defence. There were walls of earth and walls of stone according to the exigencies of the case. So in the case of this warfare between the whites and the greens, the defensive wall of the greens varies in its structure as well as in its thickness. There is a whole series of compounds known as celluloses, pectoses, etc., which have been elaborated by the green cells for specific defensive purposes in case of specific attack. On the other hand, the whites, i. e., the fungi, have armed themselves with material for the breaking down of these defensive walls. Their cells are themselves surrounded by walls, but these are of a different nature, and are, at least in some cases, more to be compared to the animal substance known as horn, than to cellulose. The protoplasm of the whites has acquired the property of dissolving and penetrating cellulose, and according to the nature of the defensive cellulose set against it, so it has acquired certain chemical properties suitable to the breaking down or dissolving of that particular kind of cellulose. The defence of the greens is, however, not confined to physical walls any more than the defence of Port Arthur was confined to masonry and sandbags. Just as the Russians armed themselves with powder and machinery for its use, so the protoplasm of the green cells has elaborated certain poison and offensive substances which are used equally with its defensive walls in keeping its enemies at bay. We all know what a vast number of different poisonous and bitter principles exist among the green plants. These have been elaborated by them, at least in part, as a defence against attacking organisms, and among them, their most powerful enemies the fungi.

This war fares not so very unequally. It might seem at first sight that the number and size of the green plants is such as to assure them the victory. We must remember that this is a war to the bitter end. There can be no compromise, no peace. Either one party must be defeated and destroyed or the other must perish of starvation. What the colorless party lack in size they make up in number and strategy. Regarded merely in the light of the number of their species the whites are most formidable enemies.

Some years ago it was my fortune to botanize extensively on an area rendered classical in the annals of American botanical science through the labors on it of a number of eminent botanists of the middle of the last century. Its flora was, perhape, at least as well known as that of any other equal area in the United States. Having occasion to go carefully over the complete list of species known to grow in a wild state on that area, i. e., within 30 miles of Amherst College, I found the total number of green plants to be very close to 1,400, while the number of species of non-green plants reached nearly 1,500. To this I must add that later research has added enormously to the number of the latter while it has increased the number of the green species known on the area by but few. From this it will be seen that the number of species of fungi and other parasitic or saprophytic plants on any given area is likely to be very great.

When we turn our attention to the number of individuals of each of these kinds of plants we find a disparity that is fairly appalling. The number of trees in a forest or the number of blades of grass on a prairie is so great as to have become a popular simile for whatever is countless.

But if these numbers are high those representing the abundance of the non-green plants are vastly higher. A drop of water may contain thousands of full-grown non-green plants. For every green plant that stands on an acre of ground there lie in the soil at its base hundreds of thousands of non-green plants. Some of these, in fact many of them, are among the worst enemies of man and his crops.

Of course each of this vast host of individuals is small, often so small as to be invisible, but there is small consolation in that. To tell me that the plague microbe is invisible only adds to its terrors. If I cannot see it how am I to fight it? An invisible enemy is the most difficult to fight. I must fight all space or run the risk of missing him.

We have glanced at the structure of an ordinary cell. Let us now bring under view the structure of a fungus.

As before remarked the fungi are most probably the decendants of green plants of some algal race. It is customary to say that they have degenerated through their parasitic habits. I am not sure that this is a fortunate expression. They have changed, certainly. From honest daylight builders of starch they have become the pirates and robbers, so to speak, of the organic world. Whether this state is a degenerate one is not so clear. We do not regard the tiger and other carnivora as degenerate. Nor do we class the eagle tribe among the degenerates. On the contrary both these types are often placed near the head of their respective groups. Those who speak of the fungi as degenerate plants possibly fail to recognize in them the superior qualities that are undoubtedly present. That the lion has lost the power of subsisting on grass does not make him inferior to the cattle who still possess that faculty. In the minds of most the lion is probably regarded as the higher of the two types. In certain qualities of, of which strength, courage and intelligence are examples he must excell or starve.

In an entirely similar manner, it seems to me, the fungi and their relatives have acquired, in the absence of the power to build starch and allied carbohydrates, faculties comparable to those of the carnivora. They have lost the art of making starch, but they have become marvelously expert in the art of stealing it. As it is hardly fair to invest them with moral attributes it is difficult to see how we can call them degenerate in one breath while we call the lion and the eagle improved in the next.

There is nothing like giving your enemy credit for all the powers he possesses. It is a policy from which your campaign will suffer no loss. So that this consideration of the remarkable powers of the fungi over other plants, and even animals will give us that wholesome respect for them without which we are likely to make grave blunders.

However the foregoing ideas may be received there is no question about the fact that the non-green plants require organic food, and that is the reason for their attacks on cane and other crops. Some of them require their food in a living condition and are thus like the tiger, while others like the hyena can subsist on organisms long since dead. There are enemies of cane among both these groups.

One of the most important things to understand in connection with the parasitic non-green plants is the manner of their reproduction, for upon this feature of their life histories often turn the most important of the remedies we are able to apply. We have seen, or at least glanced at, the method of growth of the green plant. The growth of a non-green plant is in some respects similar. It consists in a division of cells, until at a certain stage, when enough food for the purpose has been accumulated, they fructify. It is seldom that the non-green plants attain a size at all comparable to that of many of the green plants, and in consequence they as a rule attain to maturity at a much earlier age. Their life cycle in some cases occupies but few days, possibly in some instances only a few hours. They form compond tissues seldom, usually contenting themselves with lineal succession of cells which form threads which in some cases are woven together into tissues of considerable complexity such as we see in the mushrooms.

When they have attained their full size they proceed to form spores, bodies comparable in some respects to the seeds of the green plants, though really vastly different in their real nature. The resemblance consists in the fact that they are parts that are cast off, through which the organism may be replanted. It is impossible here to go into the various methods of spore formation. Suffice it to say that one of the most common methods may be compared to a boy blowing bubbles. Given one of the modern bubble machines and the restless energy that exists in the ordinary boy and you may witness the production of an almost endless succession of bubbles floating off into space. Given a fully ripe fungus, and in an almost similar manner you may witness the formation of spores on the ends of certain fungus filaments with a prodigious fecundity that almost defies description.

A single fungus will often produce spores literally by the million. So great are the numbers representing the abundance of the spores of certain crop pests that the best we can do is to make some feeble attempt to comprehend them. A single smutted oat head is large enough to contain ten million smut spores. Twenty million spores of the peach leaf-curl fungus might grow on a single square inch of a diseased peach leaf. There may be thousands of such leaves on a single diseased tree. A single grain of smutted wheat may contain seven million spores. There may be several thousands of such grains on one wheat plant. These numbers of spores produced from a single diseased plant are so great that if the spores were spread evenly over an acre of ground there would be hundreds on every square inch of surface. I have seen cane fields where the number of spores of the Rind-fungus exceeded a million million per acre. In other words over a million to ever square inch. This refers to the spores that I could have put my finger on if necessary. The number that was lost to view was doubtless greater still.

As before remarked these spores are of course very small. If they were not they would constitute the principal feature of every landscape.

Imagine bodies so small that fifty could be marched abreast through the eye of a needle. So small that thousands of them would have to be ranked up side by side to reach an inch. So small that an army of them fifty thousand strong could be comfortably manoeuvered on the end of this pencil.

I had a fancy the other day to bring here a diagram to illustrate the relative size of a microbe and a man. My first thought was to represent a microbe as a small object and then show a microscope tube with a human eye at the other end. I entered gaily into the necessary calculations for the production of this diagram. I thought a pea is a small thing. We often say, "As small as a pea." We will represent the microbe by something the size of a pea,—that being about the smallest thing that would show distinctly across this hall. When I began to calculate my microscope tube in proportion I found that it could not possibly be brought into this hall,—in fact would reach from here to Waikiki, while its diameter would be such that Diamond Head would comfortably slide inside.

As for the human eye I had proposed to show in connection with the same illustration, I leave you to judge its size when I say that a man enlarged in proportion could easily straddle the island of Oahu, or step from that island to Molokai. Or could wade from here to San Francisco without getting his knees wet.

These spores are so small and so numerous and hidden that you will at once recognize the futility of any attempt to annihilate them. Though they are without any special means of locomotion of their own they travel everywhere. They are light enough to be borne on currents of air and the air is one of their vehicles of transportation. They are even more abundant in water, and running streams of water transport even greater numbers than does the air. Insects are common agencies of transportation and very acceptable ones to the fungi, because the bites of insects often afford the spores the very chance which they are designed to improve, for most spores gain their entrance through the wounds made in the rind of the host plant. Insects are such favorable agents for this purpose that some fungi have apparently developed nectaries to attract insects to them, or have acquired an odor that advertises them to certain insects that find nourishment on their ripened tissues and at the same time carry away and distribute the spores. Man himself is one of the most important of all the transportation agencies utilized by spores. In his trade and commerce he takes parts of crops and distributes them far and wide over the world. These parts of crops often have adhering to them the spores of crop diseases. The Root Disease of cane is carried in the aerial roots to the cuttings of cane, and is thus often actually planted in the very place of all others that it would prefer. In a similar manner the spores of the Rind Disease are carried in cuttings and planted out under conditions favorable to the disease. In this case the spores are carried in the air, in water, and by insects. The diseases of the fibre of the cane, like that Gumming Disease, are extremely likely to be carried about and planted in cuttings that in some cases appear to be quite sound until they are examined microscopically. In a similar way the spores of a considerable number of the leaf diseases of the cane are carried in the remnants of leaves left attached to cuttings. Finally the diseases of the seed are transported on the seeds themselves in the case of plants closely related to cane, and therefore in all probability on the seeds of cane itself.

You will at once perceive the immense practical importance of all these facts with regard to the transportation of the spores of disease. All the more when it is stated that in a dry condition the spores of these diseases sometimes retain their vitality for years. So far as I know there are very few definite experimental results as to the vitality of the spores of cane diseases, but it is known to me that some of them resist dryness for a considerable period, in fact may be preserved in that condition longest. It is also worthy of note in this connection that dry spores often are able to resist great extremes of temperature, heat that would be fatal to them in a moist condition working comparatively little harm when they are in a dry condition. Some spores will bear a dry temperature equal to that of boiling water and still survive.

At last we are in a position to consider one of the most important of all the features of the infestation of cane in Hawaii. I refer to the accumulation of the various diseases of cane on land used for its cultivation. If the spores are so numerous and are transported by such a number of efficient agencies it is no wonder if the diseases of which they are the seed soon accumulate. On new land it may be that by proper precautions the diseases may for a few years be kept down. If, however, cane is grown continuously on that land, more and more of each disease appears each year until a certain maximum is reached. There is no way of preventing a certain amount of this accumulation. The most we can do is to limit it. I do not need to point out that if a rotation of crops is practised or if bare fallowing is practised every few years this accumulation may be considerably reduced.

I take it we have now gained a fairly good idea of the problems that confront us. The cane crops are beset with diseases that we wish to minimize, fully confident that if we can reduce them to even a small extent the result will be worth the effort. Not only that but yield a profit. Unless that end can be attained we had better turn our attention to some other subject.

The question is where can the money we propose to spend be used to the greatest advantage. There can be but one answer to this question,—Inspection and Quarantine. We must observe as carefully as possible all the characteristics of healthy cane and then treat all other cane with all the rigor that is compatible with profits. The Territorial Government has wisely provided for the inspection of imported plant material. This inspection should be keen, impartial and unrelenting. To be useful it should embody among other things thorough information as to the diseases to which cane is liable, and the appearances that are indicative of those diseases in all their stages. All diseased material that presents itself for entrance to the Territory should be either destroyed or made innocuous by distinction, in most cases the former, as it is rarely possible to disinfect a diseased plant.

As it is fairly well established that a number of the worst diseases of cane are propagated through the medium of the cuttings, these latter should undergo a careful inspection before planting, according to the methods laid down in the Bulletin on the "Inspection and Disinfection of Cane Cuttings." Be sure you know perfectly healthy cane when you see it and use no other for cuttings. This may not be so simple as it seems. We are sometimes poor observers of the very things we handle most, and none of us are so far advanced that we have nothing to learn. In all cases where doubt arises in the mind of a planter he should have recourse to expert advice, and as fast as possible he should train his own men to be his advisers. I am no advocate of centralization in this matter. A diffusion of knowledge is what we want, not a concentration of it at your central experiment station. If your station is what it ought to be it will lead and show the way, transplant its information and methods as fast as they are proved of value.

Young plants are much more sensitive to all untoward influences than older and better established plants, and in consequence they should be given the greatest attention. An attack of disease that an old plant might ward off will often be fatal to a seedling.

Medication of plants is as yet an almost unknown art. The application of fungicides is rather to be compared to disinfection as ordinarily applied in animal sanitation. Fungicides placed on the outside of plants prevent the germination on their surfaces of spores that might otherwise germinate there and find an entrance to the inner tissues. Fungicides have no other effect. They in no wise assist to cure disease already present in the tissues. While Bordeaux Mixture is the fungicide most prominently mentioned it is by no means the only one. It has, however, one advantage that makes it particularly useful, namely that of having a lasting effect as compared with some others, and as it is a visible coating so long as it is still in a useful condition, it can be recommended on that account. In particular if it should be desirable to introduce regulations as to the disinfection of plant cuttings in commerce the appearance of the plants treated with this mixture would in itself be a testimony that disinfection had been carried out. In comparison with carbolic acid, the Bordeaux Mixture may be said to be primarily a fungicide. Its effects upon insect life are very slight in most cases. Carbolic acid is equally deadly to all sorts of life but its effects are not a lasting protection against further attacks. If applied to cane cuttings its effect would be to kill the spores on the surface almost instantly. In any strength that would not be injurious to the cutting its action would cease at that point. Its action is quick and the protective effects over in a few minutes. It is so soon exhausted that it would furnish no protection to a cutting after planting. A carbolized cutting once in the ground would be just as subject to the attacks of spores in the ground as if it had never been treated. On the other hand the treatment with Bordeaux Mixture leaves the cuttings coated with a protective substance that lasts for many weeks. It will be noticed that when Bordeaux cuttings are dug up after many weeks in the ground they are in a comparatively good state of preservation when compared with untreated cuttings.

This, however, does not apply to cuttings already diseased. It is largely a waste of money to treat diseased cuttings. The only way to guard against their evil effects is to eliminate them by means of a thorough inspection according to the methods described in the Bulletin on the "Inspection and Disinfection of Cane Cuttings."

As before remarked we have forced the cane plant into a productive condition such that it is subject to disorders that are little known to it in its wild state. This susceptibility can be met in several ways.

The breeding of new varieties that are more resistant to disease and yet high in their percentage of sugar is one of these ways. At the present time this matter is receiving attention in most cane growing regions. The guiding principle in the work should be that expressed by a celebrated English breeder of dogs when he said, "I breed many and hang many." It is probable that thousands of seedlings will have to be examined to find one offering advantages over the best of our present varieties. Experience with other crops has proved that in breeding resistant varieties some other good qualities may have to be sacrificed. The resistant varieties have so far for the most part proved less profitable than the non-resistant ones when the latter were at their best. However that this has been so in the past is no reason why it should always be so, in fact the chances seem to distinctly favor the ultimate securing of resistant varieties that are at once productive and resistant. The point made here is that that end may not be so near as the most sanguine among us may believe.

At the present time it would seem to be the wisest plantation policy to give much more thought to the better care of the present good varieties, leaving to the experiment station the rearing and testing of new and resistant varieties. Of course the final test of any new variety must be the plantation test, and managers should always be ready to test any new varieties of which the station reports are favorable.

Any trials of new varieties for their resistance should be made by the row system preferably, the rows (or at least narrow plots) being made to pass across as many different physical conditions as the plantation affords. In testing for resistance against Root Disease, for instance, long rows of the new variety should stretch across fields known to be infested with the fungus and these rows should have standing next to them rows of standard varieties as checks. The object of arranging the plants in rows is to cause them to encounter as great a variety of conditions as possible. Comparisons should be made only between adjacent rows, and in most cases it will not be wise to come to a final conclusion until after trials lasting several years.

In the trial of new seedling varieties it would be well if the plants could be of known parentage, as in this way it is possible to arrive at more definite results. Chance seedlings of unknown parentage give little or no clue as to their composition, i. e. their hereditary nature, so that we remain in the dark as to the way in which we might duplicate their good qualities.

A great deal of thought should be given by all interested in cane to the subject of immunity. All marked cases of apparent immunity should be carefully studied. The physiologist should carefully study the structure and composition of resistant varieties in order if possible to arrive at definite conclusions as to the causes of immunity.

I do not know what may be the outcome of your deliberations on the question of labor on your plantations. I have heard it suggested as among the possibilities that the scarcity of the right sort of labor may lead to the abandonment of a certain portion of the land that is now under cane. Should that prove to be the case, I would suggest that if there is a prospect of securing labor at a future date so that those lands can be again put under cane, it may prove wise to bare fallow such land as is now the worst smitten and so reduce the amount of disease on those lands. After such a period of the right sort of treatment the reduction in the amount of disease would be sufficient to in some degree compensate for the loss due to its lying fallow. Or if a permanent reduction of the area under cane is necessary then an alternation of fallow and crop is a certain method of checking to some extent ravages of a number of the diseases of cane.

It is sometimes asked whether plant diseases have no natural enemies whose aid might be invoked. Unfortunately there are comparatively few suchh enemies known, though there are numerous "friends" through whose agencies they are spread.

Of the very greatest aid in the fighting of diseases spread through the agency of the soil are sunlight and air. Both sunlight and air are powerful agents in combatting many fungi. A few hours of sunlight are fatal to most forms of fungus mycelium, and most spores found in the soil. The moist condition of such mycelium and such spores renders them unfit to resist the action of the sun. The action of the air is confined more particularly to the evaporation caused by its movements. Drying the mycelium of a fungus often kills it. Spores do not germinate readily on dry surfaces. Neither does mycelium thrive in a dry situation. Moisture is one of the essential conditions for the thrifty growth of a fungus. Consequently it is during moist seasons that the losses are greatest from the attacks of fungus pests. All those methods of planting, cultivating, and caring for a crop that tend to expose it to plenty of air and sunshine will tend to reduce the losses due to disease. Of course these methods will vary with soil and climate. The distance between the plants should not be so small as to promote an excess either of shadow or stagnant air. Frequent stirring of the soil between two successive crops and while the plants are young tends by exposing the soil to air and sunlight to greatly reduce the fungus enemies of the crop. A dry and resistant condition may be maitnained on the surface of cane by judicious removal of the trash; but great care should be exercised to avoid so wounding the plants as to render them subject to the attacks of those fungi that enter at the wounds made by carelessly tearing away sheaths still having a vital attachment to the stalk. It is probable that many of the differences of opinion that exist with regard to the removal and disposal of trash are due to pathological factors that have never yet been sufficiently investigated.

The subject of drainage is now so well understood that it is not necessary here to more than allude to the fact that the evil effects of bad drainage are the encouragement of fungus growth at the same time that the roots are deprived of the air they need for healthy growth.

The relation of manue to disease may be briefly stated by saying that the promotion of a growth that is too soft and succulent is a direct invitation to parasites. Tissues of this sort are much more readily penetrated by the parasites, and when once the parasites have entered such tissues they find there the abundance of moisture that constitutes an optimum condition for their growth. The aim in manuring should be to promote a vigorous growth that is at the same time hardy and resistant to disease. So far as crop diseases are concerned the most common mistake in manuring is overdosing with nitrogen.

When a soil has become highly charged with the spores or the mycelium of a fungus disease, as it is very likely to when kept continuously under the same crop, it sometimes becomes advisable to disinfect it by the application of some fungicide sufficiently cheap to justify its use. The value of lime as a soil disinfectant depends largely on its being applied in the form of hydrate or oxide. Freshly burned lime has the maximum fungicidal effect and may be applied with impunity to soils rich in organic matter if their composition does not already present an excess of lime. As a fungicide lime should be applied at the rate of at least one or two tons to the acre. It should be applied locally rather than generally. A study should be made of the land previous to its application and in accordance with this study the lime should be applied to those parts of the soil that present the maximum of disease. In the case of Root Disease, for instance, the lime should be applied after the removal of the crop, and only along the rows of stubble in those parts of the field that have been infested with the fungus.

Which of the foregoing methods are of greatest importance in a particular case will depend on the local conditions. As I said at the outset there is no one measure that is a cure-all, applicable everywhere alike. While most of the principles outlined have a very wide application, comparatively few of them are of universal application regardless of local conditions. It would be absurd, for instance, to spend money on the artificial drainage of soil naturally well drained. The application of lime to the soil may in some cases be of doubtful value. Its fungicidal value may be more than offset by the reduction of organic matter that follows on its application.

You will, I think, have observed how closely related all these practical measures are to the fundamental facts of plant growth alluded to in the early part of my address. We propose to illustrate this still further in the address that will immediately follow on the subject of Root Disease. There you will see a particular case under these general principles, all the details of which have been worked out in the laboratory of the Division of Pathology. Mr. Lewton-Brain's address is so closely related to my own that I will suggest that all questions and discussion be postponed until he has finished.

ON ROOT DISEASES.

By L. Lewton-Brain.

Mr. Chairman and Gentlemen:

Dr. Cobb has been giving you a lecture on the general principles of how fungoid pests do their work on plants. I hope to explain to you this afternoon how one definite fungus attacks the sugar cane and the damage it does. This fungus is the root fungus causing Root Disease of the sugar cane. There is no doubt that this is the most important fungoid disease in these Islands. I have had some experience in the past with the same or a very similar disease in the West Indies. There also it is the most important fungoid disease of sugar cane. I am not prepared to say that the one in these Islands is the same, but I do say it is very similar to it in its field characters, such as its method of attack and so forth. We have here a bulletin that has just been issued on this Root Disease.

Before going into the disease, I want to say a few words about the cane plant itself, its parts, and their functions, and how the parts perform them. The parts of the cane plant, as you all know, are, first of all, the roots, then the stem, the leaves, and the flowers. The sugar cane plant has a large number of roots all independent of one another. They do not branch from one main root, but arise independently. Then there is the stem which is composed of two parts, the underground portion, which is often called the root-stock, from which the roots arise, and the portion above ground, which bears the leaves. Both the underground and above-ground parts of the stem are divided into joints. There are the nodes from which arise the buds, leaves and roots, and between these we have the inter-nodes. A joint is composed of one node and one inter-node. All new organs arise from the nodes. Then we have the leaves which are composed of two parts, the sheath which surrounds the stem, and the blade which spreads out into the air. We are not concerned with the flowers of the sugar cane.

I will next speak of the food of the cane. How does it get it, and what happens to it? The raw food of the cane comes from two sources, from the soil and from the air. From the soil the cane takes up water with nitrates, phosphates, and other salts in solution; from the air the leaves take up di-oxide of carbon. In sunlight this carbon di-oxide is combined with the water brought up from the roots and manufactured into sugar and other carbo-hydrates. The nitrates and other salts are also manufactured up in the leaves into very much more complicated compounds. These changes, of which the largest one is the manufacture of sugar and starch, take place, then, in the leaves during sunlight, and depend upon two things, to wit: the supply of water from the soil which is taken up by the roots, and, secondly, upon the carbon di-oxide taken up from the air by the leaves.

I would say in regard to sugar, that it is not kept in the leaves, but goes from the leaves down into the stem, where some is used up by the growing organs of the plant, such as the growing roots, stems, flowers, etc., but the greater part of it is stored up in the stem. It is intended by the plant primarily, no doubt, as a store of food for future use. The sugar planters have another idea of the object of that sugar.

To-day I will deal chiefly with the roots. As I said before, the roots arise from the underground parts of the stem, and always from the nodes. These roots arise in large numbers close together. The root grows to a certain length, a foot or more, and its usefulness is finished. It dies, and other roots spring out to take its place. The cane has a very different root system to that of many other plants, but it is a very simple one. If you carefully examine a root grown in moist air, you notice first that the end of the root is of a darkish color. This dark part is really a cap fitting over the actual tip of the root. This cap is composed of dead cells, the outer part at least, and is called the root-cap. Some plants have very much larger caps, which you can see are caps, with the naked eye. Then behind the root cap is seen a whitish part, which is quite smooth. Next we come to a region where a large number of very fine hairs arise, which are among the most important organs of the root. As we shall see later, it is through these root hairs, so-called, that the plant takes in its water, and mineral salts from the soil.

If you will watch the growth of the root for a day or two, you will notice that the root hairs furthest away from the tip are continually dying off and dropping away, while new ones are continually being formed nearer the tip, and this process is constantly going on.

In regard to the growth of the root in length, I would say that it is quite an easy matter to measure that by marking off fine lines at equal distances, and after a certain number of hours measuring the new distances between these lines. It will then be noticed that the growth in length of the root is confined to a very definite region. The region at the extreme tip does not elongate at all; elongation begins at a little distance behind the tip,—it is greatest a little further back, and then it sinks again until finally, in the region of the root hairs there is no growth in length at all. The root hairs then, as they develop, are not subjected to a continual dragging forward as they would be if they arose nearer the tip. As the growing region elongates, it pushes the root tip forward and further into the soil.

I will now give you some idea of the structure of the root. These regions are brought out more clearly by examining a thin section cut longitudinally through the middle of a root tip under a miscroscope. The outer part of the root cap is composed of loose cells, and if you examine them particularly, you will notice that they are dead, that is that they do not contain the protoplasm which Dr. Cobb has been talking about. These cells are being constantly rubbed off as the root pushes its way into the soil, but are as constantly being renewed from the living cells behind. As they pass out they gradually lose their protoplasm, and become dead. Of course you can see the reason for that. The outer cells being dead form a protective covering for the protoplasm-containing cells within.

Covered over by the root cap is a mass of very delicate, thin-walled, closely-packed cells which form the actual tip of the root. These cells are meristematic, that is to say they are full of protoplasm and are always actively dividing. By this means fresh cells are constantly added in front to the root cap, and behind to the other parts of the root. This is the only part of the root in which this division takes place. Dr. Cobb has described to you the process of division, and this meristem is the part of the root where such active division takes place. When these cells are formed, they are pushed off by new cells and so on. They then commence to elongate. The further you get away from the meristem, the longer these cells become. The elongation is more marked in the middle than it is on the sides.

The growth in the region behind the meristem we find is not through the forming of new cells here, but by the elongation of the cells already in existence. A certain distance back we note that the elongation ceases. Then the root hairs develop.

After the growth has ceased, the formation of the root hairs commences on the piliferous layer; a root hair is a simple tubular outgrowth from one of the cells in this layer, which is the outermost covering layer of the root behind the root cap.

In the central region of the root, another important change takes place, which is the formation of vessels. This is brought about by the fusion of separate cells. Two of these elongated cells, standing one above the other, join themselves together, and the dividing walls between them, that is the cross walls, are broken down, and the two cells become one. Whole rows of cells take part in this process until a hollow pipe or tube (in other words a vessel) is formed of considerable length. These tubes are to be found only in the central part of the root and are known as vessels, as I said before. Not only does this fusion take place, but these vessels undergo a change, by which they lose their protoplasm, that is their living matter, and their walls become woody. The walls of ordinary cells are composed of cellulose, but these vessels as they are forming become woody. The cells of the piliferous layer further back also change and become impervious to the water. The special feature is that while these woody cells are very strong, yet their walls are quite permeable to water, that is water can easily pass through from one to another. I think that is all I need to say now about the parts of the root. I have dwelt on it rather more fully in my bulletin, which you will have the opportunity of reading—if you wish.

I will now pass on to describe the way in which the roots perform their function of supplying the plant with food. The root hairs come into very intimate relation with the soil; their walls practically fuse with the solid particles, and are very thin, hence you see how easy it is for the water to pass in from the soil, into the cavities of the root hairs and from them to the plant. And here I want to mention the fact that it is the water immediately around the particles of soil which is the useful water from an agricultural standpoint, and it is with this water, which forms a film around the soil particles, that the root hairs come into such close relationship; hence we find that the water containing the nitrates and other mineral salts passes into the root hairs through these cells, and finally into the woody vessels, and it is solely in these vessels that the passage of the water takes place. As I have already described, these vessels form continuous strands, joining as they do one upon the other, and thus form a continuous channel, having no breaks, for the passage of the water; that is to say the water passing from the roots to the stem does not have to pass through any other cells but these wood vessels. The water passes up the vessels into vessels in the stem and finally out to the leaves. It is in the leaves where the various elements absorbed from the air, and brought up from the soil are, by a very complicated series of changes, manufactured into starch, sugar, and the other more complicated compounds. After these compounds are formed, they are sent down from the leaves into the stem where they are stored up for the future nutriment of the plant. Of course portions of this manufactured food, so-called, are used up immediately by the plant.

There is always a greater or less amount of water sent up through the roots to the leaves by the process above described which is not required for the manufacture of the various compounds mentioned, and I would say that this excessive water is thrown off into the air through the breathing pores of the leaves.

I will now call your attention to the subject of Root Disease, and will first point out the most notable symptoms of the occurrence of the fungus which are observed in the field. If you examine a stool of cane that is badly attacked by this fungus, you will at once be impressed with the fact that the cane is not in a healthy condition, that there is something the matter with it,—it doesn't look normal. When a cane plant is healthy, a great many leaves are visible, but when it is attacked by the fungus in question, is it noticeable that the leaves are few in number and instead of the plants having dark green, broad, spreading leaves, these appear narrower and shorter, and stand closer together. In a normal condition of health, the leaves will remain green for a considerable period of time before drying up. A plant attacked by the Root Disease fungus exhibits a strikingly different appearance; the leaves prematurely dry up, turning yellow, first at the tips and at the margins and afterwards the yellowish discoloration spreads over the entire blade. In a normal condition, the young leaves develop very rapidly, but in the case of a plant affected with the fungus this is not the case and even the leaves which are still green do not spread out in the usual way, but remain wholly or partially rolled up, standing erect.

As before explained, the excessive water passes out through the breathing pores of the leaves, and the rolling up referred to reduces the amount of water-vapor passing out into the air.

It will also be noticed that a diseased cane plant will have a stool much smaller than the ordinary one. There are also fewer canes in it and these canes are very much smaller.

Another characteristic symptom of Root Disease is seen on examining the sheaths of the lower leaves. In normal cases they dry up and fall away, and are easily pulled off in stripping; but in cases of Root Disease, these lower leaf sheaths become very closely matted together around the stem, and it requires some considerable force to drag them away. In addition to the *matting* together of the lower leaf sheaths, it is also noticed that they have a musty smell, and on making a closer examination you will see white thread-like strands running in and among and through them. These strands sometimes broaden out and instead of proceeding as definite strands they broaden out into white, flat, felt-like plates. Sometimes the strand branches and unites again to form a net work, but it always has the same glistening, snow-white appearance. These white threads or strands, and plates, are really the mycelium, that is the vegetative part of the fungus which causes root disease. "Mycelium" is a term used in connection with fungi, and it corresponds to all the vegetative organs of a green plant. The mycelium performs all the functions of the root, stem and leaves of green plants, and is, as I say, simply the vegetative part of the fungus.

If you take away the matted leaf sheaths from the stem, another symptom of root disease is disclosed in the roots, which have started developing from the nodes. In many cases they are not more than from one-quarter to one-half of an inch long, and sometimes not that long, while in all cases they appear to have had their growth stunted; in some cases the roots may have developed some distance before their growth has stopped. By examining the tips of these stunted roots closely, you will observe that they look unhealthy, that they are of a dull, dark brown or black color and are flattened. The stunted roots are often found embedded in the felt work of root fungus mycelium. This is one of the signs of the root disease, the matted leaf sheaths with the white mycelium in them, and underneath them the stunted roots. Again, if you examine about the base of the diseased cane, you will see still more evidence of root disease. In the soil you will find the white mycelium referred to. At the end of the season if you attempt to pull up a diseased cane stool you will find it comes up quite easily; with a normal stool of cane you want considerable force to remove the stool. The roots in the soil, as well as those above, are very feeble, something has happened to them which prevents them from performing their proper functions, one of which is to anchor the plant in the soil.

By the way, I want to say that you must not imagine that every time you see a white myselium in the soil that you have got the root disease. There are several fungi that have very similar mycelium to this one. They differ microscopically, however. By making an examination of such mycelia under the microscope I think I can tell some of the most common ones, anyway, but there is absolutely no difference between them to the naked eye. You find them in cane fields, out of cane fields, and all over where there is decaying vegetable matter. If you find the symptoms of root disease on the cane, and at the same time find the white mycelium about the base of the cane in the soil, this mycelium would probably be that of the root fungus. If you are not sure, send them out to us at the Experiment Station, and we will look them over. Sometimes on these Islands root disease attacks the cane very early. Cane attacked by root disease at this stage turns yellow and almost white, and looks as if it would die out. After a few weeks it very often turns green and apparently recovers entirely. If you examine more closely, however, you will find that a good percentage of these young canes have actually been killed by root disease, and that is a point on which I want to lay stress, that the apparent recovery is not, in all cases, an entire one. A certain proportion of these canes that turn yellow or white, in their young stages, and look very sick, are killed off. Of course on these young shoots you find the same white mycelium that you find on the older shoots, among the dead leaf sheaths. Besides that, root fungus has an effect on germination. I do not think there is any doubt about that here. I believe it is a matter that was discussed at the last planters' meeting, so I judge from the planters' reports, and I have seen it in the field. If you examine a cutting from a field in which there is root disease, you will find that some of the buds do not grow. The percentage of germination is less than where the soil is free from the root fungus, and you soon see the cause of that. Certain buds have started to grow. Sometimes they make a good start and sometimes they make only a very small start, before they are attacked by the root fungus, and then the root fungus grows over the bud sheaths. The white mycelium spreads over the bud sheaths, cementing them together, and sometimes it chokes the life out of the eye, as it were.

In other cases even after young shoots have been attacked with the root fungus, their growth has been so vigorous that the shoot has grown away from the fungus, that is to say has grown so fast that the fungus could not keep pace with it. If the bud is in any way checked in growth, that is if its growth is weak, then the fungus mycelium would cement the bud sheaths together so that the eye is choked to death.

I want to say a few words about the root fungus itself. As before explained the fungus consists of the white strands or threads. If you examine one of the strands under high magnification the strand is seen to be composed of a number of very fine threads; these are the hyphae of the fungus, which together form the mycelium. In the strands the hyphae run mostly in the same direction, along the long axis of the thread, but rather irregularly, interbranching and inteweaving enough to make the strand a compact whole. At the end these strands branch out in all directions, and form a kind of net work, or they may go on growing as they are, anywhere where there is any food.

There is one feature about this that is interesting to me, and to anyone who has got a microscope. I think there is one way of identifying this mycelium, and distinguishing it from some other fungi, and that is the crystals on the hyphae. In the root fungus, (in nearly every case I have examined), I have noted these crystals standing out from the main thread. They seem to be borne on little separate branches and are arranged in the shape of a star. Crystals are quite common in fungi of the same sort, but I think the root fungus crystals could be distinguished from the crystals of any other fungus by reason of their being arranged in these star-shaped clusters appearing on hyphae, which stand away from the general course of the strand. Besides these clusters single crystals are sometimes found in great numbers, studding the walls of the ordinary hyphae. In many other fungi you get the single crystals, without getting the star-shaped clusters, and then in other fungi that I have seen you get crystals of different shapes, as needle-shaped crystals embedded in the walls of the hyphae. It is a point to which I have been paying a little attention. It seems that these star-shaped clusters of crystals furnish a way for identifying the root fungus and separating it from other soil fungi. But, it may be that when I have examined a few more fungi, I will find that these crystals are quite common; so far, however, I have only found them in the hyphae of the root fungus. So much for the vegetative part of the fungus.

Now I will say a few words about its reproductive organs, which by the way, we have not discovered yet. We are inclined to think that this fungus belongs to the toadstool fungi. These are the highest group of the fungi, and their reproductive organs take the form of these toadstools. You see the threads give rise to a quite complicated structure, consisting of a long, thin, white stalk, with a flat cap or expansion at the top. On the under side of this cap you get a number of flat gills or lamellae hanging down, and it is on these gills or lamellae that the spores of the toadstool are borne. Now we have in the West Indies, as I said before, a very similar root disease to this one in Hawaii, and they have a very similar disease in Java. They are caused by a fungus having this fructification. We are inclined to think for many reasons that the reproductive organs of the Hawaiian fungus will be, when found, either identical with those of the West Indian root fungus, or very similar, and the Division will be very glad to have any specimens of small white toadstools that are found growing about the base of the cane. Whenever I found this fungus it was generally growing from the root or from the leaf sheaths at the base of the cane, somewhere near the soil. The specimens I have found were never more than an inch across the cap. That was quite early in the morning, when they were expanded. These toadstools are not very easily found. I suppose during the three years in the West Indies I did not find them more than three or four times in the field, or get them more than three or four other times in the laboratory. So they are not so abundant as some people seem to think. However, we are trying to do all we can at the laboratories in this Territory to obtain a fructification from the white mycelium of our root fungus, and may be able to tell whether we have the same disease as in the West Indies or not. But until we get these fructifications. and until we are sure that they are the fructifications of that root fungus, of course we can't tell whether our disease is the same as that of Java or is the same as that of the West Indies, and it is of some importance to know that, because if it is the same we need not be particular about importing canes from those places; if it is not the same then we should be very strict in importing, so that we do not introduce the disease.

That is the practical point of it. Of course it has a scientific interest as well. We are trying all we can to get hold of these fructifications, and then after we have hold of them we will carry on some inoculation experiments, and so on, and I hope to publish the results later on. This fungus, as I was going on to explain, spreads nearly entirely by means of its mycelium, just like the sugar cane plant, which has been propagated hundreds of years, by cuttings and not by seed. It is propagated by its mycelium, especially through the soil. If you carry away a cutting with some of these dead roots in it you are carrying away the root fungus. And I would say that the root fungus propagates itself almost exclusively through its mycelium. Even in the West Indies and Java, where the fructifications occur, the fungus does not spread much through its spores, but by its mycelium. We want to get the fructifications chiefly for the purpose of identifying the fungus.

I now pass on to describe the structure of a diseased root. This can be seen by examining a longitudinal section of one of the stunted roots which I have mentioned before. The root cap appears flatter, its cells show no graduation from the living cells near the meristem to the dead cells outside, but they all appear dead and flattened. Evidently cells are not being formed at the meristem to replace those worn away in front. The growing point itself also looks unhealthy. Its cells are not so full of protoplasm and division is not taking place so actively. By examining very closely one discovers in and among the cells of the root cap and meristem the hyphae of the fungus. These enter the root cap first from the soil and pass from there into the meristem. Once there the fight between the fungus hyphae and the plant cells goes on in the manner described by Dr. Cobb. As the outer part of the cap of the tip is composed of dead cells which do not offer much resistance to the fungus mycelum, the real fight or struggle occurs when the living or inner cells are reached by the hyphae. Here the fungus takes the food, that is being supplied by the plant, away from the dividing cells, thus starving them, and retarding their activity. Of course these dividing cells take up a good deal of the food supplied by the plant which comes down from the stem, and as the fungus goes right to the point where the food is supplied, it starves the dividing cells and finally the meristem is killed and the growth of the root ceases. Hence, inasmuch as new cells are not formed except from the division of cells already in existence, if those cells are destroyed or killed by the fungus mycelium, nothing is left with which to form new cells, and that root as a consequence dies. All growth has ceased because there is nothing left with which to form new cells. Hence, as the old root hairs die, no new ones are formed; no new vessels will be produced. When new growth stops, all activity of the root is at an end. The hyphae do not spread much beyond the growing point, that is they do not enter the central part of the root, but as you see the vital part of it all is that it attacks the actual dividing region where new cells are formed. When a root has stopped growing, a new root must be developed to take its place. The cane has been put to some expense, as it were, to form a new root. Let us suppose a case.

The old roots decay naturally or have been killed by the fungus mycelium, and the new roots are prevented from developing by the fungus, as this continues to destroy them. If that goes on for a while, the cane plant is going to feel the effect of it beyond the immediate neighborhood of the attack, for the reason that the leaves do not get the amount of water they require, nor the amount of mineral salts absorbed from the soil. As soon as a considerable portion of the root system of cane is affected, the water supply carried to the leaves through the stems from the roots will also be affected, which explains why the leaves dry and curl up and stand upright. It is on account of an absence of water. They show that they are in need of water which they cannot get from the usual channels,—as it were, the cane commences to "shut up shop." It is not healthy. But not only is the water supply lessened considerably, but also the supply of gas from the air begins to be cut off, owing to the leaves being rolled up and standing upright, hence the free access of air into the cane pores is shut off which lessens the amount of sugar and other elaborated food formed in the leaves. The effect is seen first on the leaves, and then if the fungus continues to get the upper hand, the whole plant suffers from starvation. The root system is poor, it cannot take enough water or mineral matter from the soil, and the leaves are not developed as vigorously as they should be under normal conditions on account of not receiving sufficient water through the stem.

I have put the matter at more length in my bulletin and suppose you will read it there; but that is the explanation of the damage done by the root fungus.

To carry out Dr. Cobb's simile, likening the struggle between the fungus mycelium and the cane plant to a war, I would say that I would compare the root fungus to a very active enemy that cuts off parties sent out to get supplies. Suppose the sugar cane is the green army and the roots compared to a foraging party sent out to bring in supplies. The root fungus is the white attacking army which surrounds the green and cuts off its supply parties and so gradually starves out the green army. Of course your sugar cane does not always go under in the way; in fact in a great many cases the sugar cane will throw off the attack of the fungus provided it is stronger than the fungus and can grow away from it, and the cane form new roots quicker than the root fungus can destroy them. It all depends; if the fungus is vigorous and strong and the sugar cane is weak, the fungus will destroy the roots quicker than new ones can be formed; on the other hand if the cane is vigorous and the fungus weak, or just commencing to get a hold, in that case if the cane can provide new roots quicker than the fungus can destroy the old ones, why the cane will simply grow away from the fungus and will not suffer from its attack, because a good strong, healthy cane is not going to suffer from a fungus. It is only when the cane is weaker than the fungus that the damage is done. If you can get your cane to form good strong vigorous roots, then you have done for the root fungus, because the root fungus is not capable of attacking a good, strong vigorous root system and damaging it to any extent. I do not want to keep you too long, but I would like briefly to outline the treatment for this disease.

I have mentioned the spread of the fungus through the soil from one plant to another, and that this fungus is carried by diseased cuttings. If you take one of these diseased cuttings with you from one place to another you are also taking with you the root fungus that is contained in it and even if you strip off the leaves the root fungus is there in the dead roots just the same and you are still carrying with you the fungus.

The first line of treatment is that of cultivation. When you have the root disease, you want to cultivate and turn up your soil and expose it as much as possible to the action of the air and sunlight. That does good in two ways: It encourages a vigorous development of roots by having the soil well aerated and also it kills out part of the root fungus. Soil fungi especially, and many others, are best suited by other conditions, that is, as long as they can keep in the dark they will go on growing—that is true of the root fungus—it prefers the darkness, but if you keep turning up your soil and exposing the fresh parts of the mycelium to the sun and air, you will kill it and get the upper hand. So cultivation cuts both ways: it improves the vigor of your roots and it also destroys part of the root fungus mycelium.

Another thing is to use healthy cuttings. Don't by any chance plant diseased cuttings. Don't plant any cutting from a field that is affected with root disease. You may think it is all right to take cuttings from above where you see the mycelium of the fungus, but it is not, because if the fungus is there, no doubt it has already spread beyond where you can see it, and it is best to leave as wide a margin for safety as you can. The best plan to be followed isw to leave entirely alone such a field, no matter how little it is affected.

In the West Indies there used to be a practice of taking the worst canes for cuttings, because they were no good for grinding. In that way, when I went there, at least at first, a great many cuttings containing root disease were used as seed simply because they were no good for grinding purposes, but I do not think that the intelligent Hawaiian planter is going to do anything like that. The breeder of animals would never do that. A cow or any other animal that was attacked by any serious disease should not be used for breeding purposes, and so it is with plants. Breed them from healthy stock. Don't take any cuttings whatever from cane which is affected by root disease.

Then we have some experiments which show that by treating the cuttings with Bordeaux Mixture you can prevent that loss of germinating power: in that Bordeaux Mixture will destroy to a great extent the root fungus which attacks the cuttings from the soil and thus prevent a good percentage of loss from non-germination.

I will skip most of the other remedies in the list except that of resistant varieties. We have on these Islands a variety called Yellow Caledonia, which is very markedly resistant to Root Disease. The Lahaina and Rose Bamboo, as I have seen in many places, have been badly attacked, but so far the Yellow Caledonia appears to give good crops even on those fields where the root fungus is very bad. What the cause of this resistance is and why it should be, we do not know.

Then some of the new varieties that are being originated at the Experiment Station may prove to be disease-resistant. We hope so. We do not, however, ever expect to get a cane that will be entirely immune to root disease. Yellow Caledonia is not entirely immune to root disease, nor any other cane that I have ever heard of; but we hope to get some even more resistant cane than Yellow Caledonia. Before we can do that we have got to have trials on a large scale on infected land and they must be carried out on the plantations. We can not carry them out at the Station.

Mr. Smith—I would like to ask, whether there is a root disease of the cane besides the disease you have described?

Mr. Lewton-Brain—There are two or three fungoid diseases of cane known in Java.

Mr. Smith—Have you noticed any others here or have any been pointed out to you?

Mr. Lewton-Brain—I have only noticed this one root disease here. The entomologists might tell us if there are any insects which attack the roots of the cane.

Mr. Scott—Has the Pineapple Disease any relation to the Root Disease?

Mr. Lewton-Brain—No; it is an entirely different fungus altogether. It also occurs both in Java and the West Indies. We know the reproductive organs of that fungus.

Mr. Baldwin (the Chairman)—Have you any definite information as to how long the root disease has been in the country?

Mr. Lewton-Brain—The only thing I can say is that I have shown typical specimens to several plantation managers and they have always assured me that they have known it for some years, but that they never realized what it was.

The Chairman—From your description, I should say that I have known it here for fifty years.

Report of Committee on Manufacture.

To the President and Board of Trustees of the Hawaiian Sugar Planters' Association.

Gentlemen:—At the request of the President of this Association your Committee has divided the work of preparation of this report over the various members as follows:

Clarification of Raw Juice, Mr. Wm. Stodart, McBryde.

Recovery of Sugar from Scums and Settlings, Mr. E. K. Bull, Oahu.

Boiling and Drying No. 1 Sugars, Mr. E. Madden, Kukaiau.

Treatment and Boiling of Molasses Sugars, Mr. Williams, Puunene.

Preparing Product for Shipment, Mr. J. Watt, Olaa.

General Control of Manufacture, Mr. J. Scott, Hilo.

A report on Factory Work in General made up from the weekly Bulletins issued by the Experimental Station, is also attached.

Individual reports follow:

CLARIFICATION OF RAW JUICES.

Eleele, Kauai, July 12th, 1905.

Clarification has for its object the elimination of all non-saccharine matter from the juice, and lime is the principal agent used. It is, indeed, almost the only one besides heat, for although there are many supplementary agents used, the foundation of every system of defecation is lime, and those systems only differ in the mode of applying the lime. While nobody will accept the rather startling doctrine of a recent writer in the "Beet Sugar Gazette" who asserted that there is no sugar in cane juice until it reaches the clarifiers, it is certain that clarification is the most important operation in the treatment of raw sugar juice, and the boiling, the loss in molasses and the keeping qualities of the sugar are directly affected by it.

The action of heat and lime is to remove all of the albumens, cane-wax, phosphoric acid and inorganic bases except alkalies, and part of the gums, pectine and organic acids. It is impossible to remove any of the alkalies or all of the gums, glucoses or organic acids and bases, and these (with the excess of lime) go to form the molasses.

The general practice in these islands is to temper the juice so that the clear juice is slightly alkaline to litmus. Some factories keep their liquors neutral while a few on Hawaii work with acid juices. J. Troude deduces from the researches of M. L. Lindet that the juices and syrups should be kept alkaline not so much to avoid their becoming acid as to prevent their becoming neutral, for it is in neutral solutions that certain salts and metallic acids promote auto-inversion. While there is little objection to acidifying juices which have been first limed to alkalinity and clarified, the practice of leaving the juices with their natural acids free cannot be defended; the sugars in the latter case will be light colored but subject to inversion, and the molasses will be low in purity (or rather—putrescent) but will contain a large proportion of inversion products. On the other hand. an excess of lime produces organic salts under the influence of heat and so increases the quality of molasses. Geerligs and nearly all other authorities insist on a clarified juice which is faintly alkaline. If an excess of lime is necessary to effect complete precipitation the excess should be neutralized with sulphurous, phosphoric, or carbonic acid; if defecation is complete before the juice is alkaline, the acidity should be destroyed by carbonate of soda.

The mode of applying lime varies little in the Hawaiian Islands, a measured quantity of lime being added to a measured quantity of juice. A few factories use a lime-milk of a definite strength and allow a constant stream to flow into the juice as soon as possible after it leaves the mills. One factory applies all the lime on the cane after passing the first mill, as described in the Machinery Report to the H. S. P. A. for 1903. M. Weinrich of Cuba, has elaborated this last method, and patented a process in which he tempers the juice while it is still in the cane, so that the mills extract clarified juice. G. Hagemann of St. Croix, W. I., tempers the third mill juice and uses it for maceration behind the first mill. These three last processes reduce the quantity of mudcake.

Among recent improvements in clarification may be mentioned the Lehmkuhl process in which the quantity of lime required may be reduced 60 to 70%. In this process the albuminoids are coagulated by heating the juice before liming to 90-95 C. with a small quantity of aluminium sulphate and sulphuric acid. The small quantity of salts thus introduced offers no disadvantages compared with the molasses-forming amido-acid salts formed from lime and albuminoids.

K. R. Hamakers of Java, displaces part of the lime by ordinary soil. Any soil will serve the purpose, according to Mr. Hamakers, but probably a marl will give most satisfactory results. The use of alumina and clay for rendering turbid liquids bright is well known, while the chalk of marl will neutralize some of the natural acids of cane juice. Marls are practically non-existent in these islands (*vide* Maxwell's "Hawaiian Lavas and Soils"), but pulverized coral, alone or mixed with clay soil, will answer. A recent patentee uses a mixture of lime and powdered brick in clarification.

Weisberg's sulphi-carbonatation process is highly spoken of in France, but is mainly intended for the production of white "refined" sugar.

Electrolytic clarification in Europe and superheat clarification here are both moribund.

Intermittent settling is general in Hawaii, although one factory uses continuous settlers with pronounced success, while at least one factory dispenses altogether with settling tanks and takes the juice direct from defecators to evaporator.

The filtering of scums through filter-presses is universal in modern sugar factories, and the apparatus and manipulation vary so little in different mills that nothing new can be said here.

The filtering of clarified juice is now practiced in a number of Hawaiian factories. The Stade (Abraham) sand filter is the type of filter most commonly used and gives fairly good results in some mills, but in most mills its work is somewhat unsatisfactory. This may be due to the use of an unsuitable grade of sand, or to forcing the apparatus beyond its capacity, but at any rate the layer of sand through which the juice passes seems too thin to give a good filtration. In one factory the juice is filtered through two feet of sand in ordinary tanks with perforated false bottoms, and the results are excellent. W. D. Lowell of Maui, has devised a juice filter in which the filtering medium is "excelsior," and its work has given great satisfaction. Bagasse filters have been unsuccessful.

The advantages of filtering well-clarified juices are not quite established. The evil wrought by the fine mud that does not settle is perhaps more imaginary than real, and it seems wasted labor to remove this small quantity of mud when the brightest filtered juice deposits a sediment in the storage tanks after concentration. It has been stated that the fine mud makes molasses, but none of the authorities can be quoted in support of this contention. Inert suspended matter does not "require water for its solution" and therefore does not prevent the crystallization of sugar. If it contains nitrogenous matter it may cause a slow fermentation and loss of sugar, but this action has not been demonstrated. The conclusion is therefore justified that the 'melassigenic" power of the suspended impurities is *nil*. The most evident effect of the fine mud is on the color of the sugar, but this calls for no special attention when refining crystals are being made. The polarization is but slightly affected, and the color is not considered by the refineries in calculating the value of a shipment. Where sugars have to pay duty, a fine color is rather a disadvantage. The real evil of fine mud in sugar liquors is the fouling of the heating surfaces. Whether or not the expense and inconvenience of fighting this evil with acids, scrapers and "elbow-grease" are greater than the cost and upkeep of a juice-filter installation, is a point which can only be decided by those who have tried both methods in the same factory. Those qualified to give an opinion hold such divergent views that the economy of juice-filtering is still a moot question.

Respectfully submitted,

JAS. W. DONALD.

At the request of Mr. Wm. Stodart, member of Committee on Manufacture.

BOILING, AND DRYING NO. 1 SUGAR.

MR. J. N. S. WILLIAMS, *Chairman*, Committee on Manufacture, H. S. P. A.:

In response to your request that I prepare a paper on Boiling, and Drying No. 1 Sugar, I beg to submit the following remarks covering the ground suggested by you, at the same time, regretting that there is so little data available on this subject.

I find, however, from the few replies that I have been able to obtain, from those factories which have answered my queries: that the majority practice much the same method in the manufacture of their No. 1 sugar, that I have always advocated, viz: getting as much dry sugar as possible into the No. 1, as a matrix, with the addition of as much molasses as the sugar will stand.

It does not appear that there is any advantage in working a syrup of high density from the evaporators (the general practice seems to be to work with a density of from 28 to 33 Baume), nor have I any data showing different results from different densities; the all important questions of economy of time, saving of fuel, polarization of the sugar shipped, and amount, and quality of the final molasses, are, as they have always been, the questions which confront the sugar maker.

I find then that it is the general practice to take in from 10% to 20% of dry sugar into the syrup, the strike being carried to completion with syrup, and the addition of No. 1 molasses, this molasses varying from 10% to 20%.

The addition of the dry sugar has no effect on the boiling of the strike, but the quantity of molasses added as well as its purity undoubtedly has some effect.

The dry sugar thus taken into the syrup polarizes from 86 to 92 degrees, and the molasses added has a purity of from 58% to 65%. From experiments made here it was found better to dilute this molasses with water, and there was no advantage to be gained by drawing in part of the molasses into the strike at one time, and part at another time, in fact the results showed it was better to take it all in after the required amount of syrup had been utilized.

The taking in of dry sugar has the effect of saving time in boiling a strike, but as some of the sugar is handled twice this advantage is negatived if it is not backed up by a saving in the subsequent operations, as for instance, the boiling of the No. 1 molasses to cooler-car proof, where there is a saving of time in boiling of from 1 to 2 hours per strike, as against grain in the pan, and this sugar being dried cold is sufficiently free from lumps to pass rapidly from the hopper into the pan.

As is well known, the molasses adhering to the sugar, about 10%, gets washed off in circulating in the syrup, but, it does not appear that this molasses adds to the quantity of waste final molasses, but is absorbed in the following boilings.

The water content of the massecuite is about 8% to 10%, but in mills where pans have small gates, the practice is first to boil stiff, and liquify the massecuite before discharging by a charge of No. 1 molasses.

There is a diversity of opinion as to the relative advantages of a slow, or a quick boiling pan; personally I prefer a fast boiling pan, as there is a saving of steam.

The addition of molasses into the strike of No. 1 has a good deal of effect in the time of drying such strike. I am told that a pure strike will dry in one-third of the time that one will having a large quantity of molasses, but we have not noticed any material difference here, possibly because we do not take in so much molasses.

We have no comparative data on use of dryers, and without but it would be interesting to know how far the use of dryers affect the keeping qualities of the sugar; no one, nowadays, or at least very few mills, use any water in drying the No. 1 sugar in centrifugals, in fact it is generally conceded that this is a practice that gives very few advantages, compared with the object to be gained. With a Hersey Dryer it might pay to wash some grades of sugars, but without this apparatus, very few mills attempt this practice.

The question of what is the most economical sugar to manufacture is a most important one, and it is generally admitted that a sugar polarizing from 96.5 degrees to 97.5 degrees, is the most economical sugar to make, and ship one grade as above, there should be as little loss in polarization through sweat damaged sugar as possible.

E. MADDEN.

July 8th, 1905.

TREATMENT AND BOILING OF MOLASSES SUGARS.

It is the almost universal custom in this country to work over the molasses in several stages, the only exceptions being those factories using the Java Process whereby the low grades are worked in with the No. 1 sugars at once.

It is the practice in all factories to work in more or less of the molasses from No. 1 sugar with the first massecuites, as described in the report in Boiling and Drying No. 1 Sugars; the remainder of the No. 1 molasses is boiled to grain or proof as the case may be, and held in crystallizers or cooler cars for a certain time and then spun off in centrifugal machines.

The method of treating this second sugar varies considerably, some factories fitted with sugar driers wash the second sugar with water in the centrifugal machines, pass the product through the driers, bringing it up to 96% polarization or higher, and ship the same direct. Other factories not fitted with sugar driers, after spinning the second sugars remelt it and work it in with the straight syrups for No. 1 sugars; others again draw this second sugar dry into the vacuum pans, and in this manner convert it into a shipping sugar polarizing 96% or over; and there are still others that ship second sugar as such, the polarization varying from 93% to 95%.

All of these systems of work produce good results, but the selection of the system best adapted for any one case largely depends upon the mechanical arrangement of the factory.

The runnings from second sugars known as second molasses, in almost every factory are boiled, discharged into tanks or cisterns, allowed to stand for some considerable time and then machined, the resulting low grade sugar in all cases being remelted and taken back into manufacture for conversion into shipping sugars.

The boilings of low grade molasses are always made to string proof or to density, the more viscous and sticky the material is the lower the density must be to produce a grain that can be recovered.

Very little is known about the laws that govern crystallization in these low grade massecuites, and no hard and fast rules can be made, but it appears to be certain that it does not pay to handle very low grade molasses unless it is reinforced by the addition of a sufficient quantity of richer material to bring up the strength to such a point that the apparent purity of the massecuite shall not be less than 45; if this system is adopted, a standard for quality of waste molasses must be set, and all residues of this quality or lower should be thrown out of process. This standard, which will vary in different places, depends largely upon the purity of the original cane juice and must be found by experiment. In the treatment of second molasses before boiling, every effort should be made to raise the purity, or in other words, to remove some of the solids not sugar from the material operated upon.

It has been found that the apparent purity of tank massecuites should not be less than 45, and the recovery of pure sugar from such massecuites of different densities is given in the following table compiled from the results of the 1905 crop at the Puunene Mill:

Apparent Brix.	Apparent Purity.	Pure sugar in sugar recovered % of massecuite.
88–90	44–46	10%–15.0%
90–92	44–46	16%–20 0%
92–94	44–46	17%–25.0%
94–96	44–46	15%–22.0%

The time during which these massecuites remained in the tanks or cisterns varied from 26 days to 86 days, and the waste molasses resulting from these massecuites varied from 26% Pol. to 32% Pol. Apparent purities varying from 29–37.

The total loss in the waste molasses depends upon the average quality of shipping sugars, as well as upon the quality of the original cane juice; and as Hawaiian sugars are sold under contract based on the New York price for 96% goods, with a bonus for higher class sugars and a penalty for lower class sugars, the following observations may prove of interest and value. No. 1 sugars are made from syrups containing certain fixed quantities of pure sugar and solids not sugar; it is therefore evident that the higher the polarization of the shipping sugars, the greater must be the quantity of molasses resulting from the separation of the syrups into sugar and waste, for the reason, that if the non-sugars are not sent to market with the shipping sugars they must of necessity find their way into the waste molasses, thus increasing its weight and the amount of pure sugar carried off with it.

Therefore it is evident that if 100% sugar is marketed the greatest possible quantity of waste molasses from a given quantity of syrup will result; and if a shipping sugar that contains all the non-sugars in the original syrup be made there will be no waste.

The following table is a statement of the returns from cane syrups of the following analysis:

Brix	60%
Sugar	54%
Purity	90%

this converted into No. 1 commercial sugars leaving the resulting waste molasses of the following analysis:

Brix	89%
Sugar	30%
Purity	33.7%

and assuming that there are no chemical or mechanical losses during the operations of boiling to grain and preparing for market.

Table of returns of Commercial Sugar and Waste Molasses from 100 tons of syrup of the foregoing analysis:

Polarization of Sugars.		Tons Commercial Sugar.	Tons Waste Molasses.
Dry	100%	50.95	10.17
Containing ½ of 1% Moisture	99%	51.602	9.724
	98%	52.399	8.833
	97%	53.229	7.907
	96%	54.077	6.958
	95%	54.951	5.981
	94%	55.865	4.959
	93%	56.800	3.914
	92%	57.699	2.822
	91%	58.777	1.704
	90%	59.823	0.535

The above figures are accurate as the moisture in the shipping sugars taken at ½ of 1% has been included, and they can be relied upon to furnish correct conclusions.

It will now be seen that when making 96% sugars the quantity of waste molasses of the specified grade is 27% less than when making 98% sugars, and the pure sugar shipped is 1.1% more in the 96% than in the 98% sugars, resulting from working up a given quantity of cane, and these facts have a bearing on the question of the most economical grade of commercial sugars for shipment under our present contract.

Respectfully submitted,

J. N. S. WILLIAMS.

PREPARING PRODUCT FOR SHIPMENT.

Olaa, Hawaii, June 27th, 1905.

Before the introduction of the Hersey Dryer it was necessary to keep the sugar in the Centrifugal Machines for a few minutes longer than at present, in order to reduce the moisture slightly below one per cent.

The Massecuites, being still hard to sugar in the machines, had a tendency to form hard cakes, which, of course, could only be removed with difficulty. The discharge of the machines involved a waste of time, and was very trying on the Centrifugal Screens.

After the introduction of the Dryer, not only did it become superfluous to dry the sugar in the Centrifugals to the former degree, but it could not be done, owing to the blocks of sugar which formed, and which could not be crushed in the drying process but were thrown out as residues, like pieces of partly burned sugar, etc., and this had to be remelted.

The sugar now remains in the Centrifugal Machines only to the point when it begins to pack; containing from two to two and one-half per cent. moisture, it can be dropped out in a minimum time, and without injury to the Centrifugal Screens.

This, of course, considerably increased the capacity of the Centrifugal Department.

The sugar of the different grades from the Centrifugal Machines drops together in a common carrier, which conveys it to the box above the Dryer. From this, through a feeding Screw, it is taken in a continuous stream through the Revolving Dryer, in which a current of hot air of 80° C. carries away the moisture, leaving the sugar nearly perfectly dry.

This dried sugar, after passing through a revolving strainer falls through a chute in a continuous stream into the bags, which are supported on trucks.

The full bags are then trucked over a scale, brought to the required weight, and thence trucked to any desired point in the sugar room, where the bags are taken off of the trucks and sewed.

The large amount of labor required to handle the sugar after it leaves the Dryer shows how desirable it would be to have a practical machine, one which would do the bagging, weighing and sewing.

In connection with such a machine it would be well to build a small carrier running backward and forward parallel with the sugar-cars, thus reducing the cost of handling and the losses in the sugar room to a minimum.

Before closing it may be stated that the introduction of the Hersey Dryer into the sugar mill is a decided step in the right direction, adding greatly to the guarantee that the sugars will arrive at destination without deterioration, besides enabling us to ship about one per cent. more molasses, retaining the former polarization. This, of course, means that after working the first eight or ten thousand tons of sugar, the Dryer has paid for itself.

We boil our first massecuites to 93.5° Brix and 77.5 Purity.

The sugars of the different grades, mixed together, when entering the Dryer polarize from 94.5 to 95. (2. to 2.5% Moisture). After passing through the Dryer it polarizes from 96.5 to 97. (.25 to .5% Moisture).

It is difficult to state the actual time necessary to dry off the No. 1 massecuite, as this work has to be regulated so as not to exceed the capacity of the dryer, the capacity of the latter being less than that of the centrifugal department.

Independent of the dryer, with eight (8) centrifugals, we can dry off a strike of the above Brix and Purity in from three to three and one-half hours, producing four hundred (400) bags of sugar (about twenty-two (22) tons).

In regard to the request for the landing, polarization and weight of our sugars, regret that this information cannot be furnished at this writing, our account sales not having come to hand.

Respectfully submitted,

G. GIACOMETTI,
Chemist Olaa Mill.

At the request of Mr. J. Watt, member of Committee on Manufacture.

GENERAL CONTROL OF MANUFACTURE.

In a workable scheme for sugar house control there are certain figures that are essential; they are:

1st. The cane weights;

2nd. The weight of sugar taken into manufacture, and

3rd. The weight of residues containing sugar passed out from the factory during manufacture. Upon the accurate determination of these depend the value of the work done.

In order to ascertain the ideas of those directly interested in factory work the following questions were made up and forwarded to all the Managers on the Islands:

"*1st. Cane weights and the deductions from the gross weights to allow for field trash, roots, dirt, flume water, etc., and your ideas of the proper method to be followed in obtaining the figures.*"

"*2nd. Juice weights, and the amount of sugar taken into manufacture, whether this should be by measurement of the juice direct, or deduced by formula from cane weights.*"

"*3rd. Weights of shipping sugars and checks on same.*"

"*4th. Weight or quantity and quality of waste molasses.*"

"*5th. The basis of control, should it be the sugar in the cane,* *or the sugar in the juice delivered to boiling-house; by this I mean the actual daily control, whereby the Manager can see how much sugar is delivered to factory day by day and how much bagged."*

A number of replies have been received from which it is evident that very divergent ideas prevail as to what is required.

Some think that no deductions should be made from the cane weights to allow for field trash, dirt, roots, flume water, dead cane and so forth; others believe that such deductions should be made.

Some consider that juice should be weighed, others that it should be measured, others that it be deduced by formula from cane weights.

Your sub-committee believes that the following scheme of sugar-house control covering the three classes of weights specified above will be acceptable to most plantation managers in these islands:

CANE WEIGHTS:—These should be the net weight of cane ground obtained by deducting from the gross weight of cane the weight of field trash, roots, dirt, flume water, etc., at the time the cane is weighed, so that the cane weighers' sheets will give the net weights.

The reasons that the net weight of cane should be used are:

1st. Accurate field accounts can be better kept.

2nd. There is less liability of dispute with contractors over cane weights.

3rd. More accurate estimation of losses of sugar in the bagasse.

JUICE WEIGHTS:—Juices should be weighed if possible, if not then measured in large tanks of 2000 to 3000 gallons capacity; juice weights should never be calculated from cane weights.

RESIDUES:—Filter press mud should be weighed, waste molasses should be measured.

The basis of control of manufacture should be the weight of sugar in the juice taken into the boiling house for the reason that this weight is much more likely to be accurate than the estimation of weight of sugar in the cane.

Respectfully submitted,

J. A. SCOTT,
Member of Committee.

FACTORY WORK FOR CROP 1905.

In accordance with the recommendations of the Joint Committee appointed from this Association and the Hawaiian Sugar Chemists' Association at the 1904 meeting, a number of plantations sent in weekly crop reports to the H. S. P. A. Experiment Station in Honolulu, where these reports were condensed into one weekly comparative statement, copies of which were sent to all in the exchange every week.

The following figures were taken from these statements and cover the period of grinding from February 4th to June 3d, 1905. Some twenty plantations joined in the exchange and all the Islands where cane is grown are represented, so that the figures give a very fair average of the quality of cane and class of work done during the above period for the Territory of Hawaii.

MILLING WORK.

Average for 20 factories, one fitted with a 12-roller mill and 19 fitted with 9-roller mills:

Tons of cane ground per hour (one mill)		30.42
Pure sugar in first mill juice	17.96%	
" " " cane	15.08%	
" " " true cane juice	17.17%	
" " " bagasse		3.81%
Dilution—per 100 normal juice		22.72%
Moisture in bagasse		45.07%
Fibre in cane		12.16%
Extraction per 100 pure sugar in cane		93.79%

With good average work in the factories, the foregoing average cane should produce one ton of commercial sugar of 96.5% pol. from 7.5 tons of cane.

No complete crop reports are available to your Committee on Manufacture, so that actual results in tons of cane per ton of commercial sugar are not forthcoming, but the above statement is given so that each plantation manager can judge of the character of the work of his factory for himself.

The following is an itemized statement of the quality of the cane and work in the aforesaid twenty factories for the period from February 4th-June 3d, 1905, and special attention is called to the differences in the quality of the first mill juices and that of the true cane juice at each place. The sugar in the true cane juice is found from the figure representing the sugar in the cane and the fibre in the cane thus:

It is required to find the quality of the true cane juice when the sugar in cane is 15.08% and fibre is 12.16% then

$$\frac{15.08 \times 100}{100 - 1216} = \frac{1508}{87.84} = 17.17\text{—}$$

List No. of Factories.	Size of Mill Rollers.	Tons of cane ground per hour.	Polarization 1st mill juice %.	Pure sugar in cane %.	Polarization of the true cane juice %.	Fibre in cane %.	Dilution per 100 of normal juice.	Extraction.
1	32x66	22.17	17.73	14.32	16.26	11.94	32.29	95.42
2	34x78	33.6	17.27	14.28	16.18	11.70	41.71	95.81
3	32x66	17.84	17.15	14.24	16.15	11.85	16.91	92.95
4	34x78	42.14	19.00	15.94	18.17	12.28	26.06	92.18
5	34x78	36.91	17.97	14.76	16.63	11.26	42.33	94.97
6	34x84	30.19	19.27	15.99	18.14	11.85	28.00	94.27
7	32x66	37.12	19.21	16.12	18.66	13.63	16.45	94.02
8	32x66	38.47	18.43	15.16	17.62	13.95	25.70	94.00
9	32x66	21.10	17.74	14.62	16.69	12.39	8.32	91.52
10	32x66	30.03	17.79	15.18	17.41	12.82	21.72	92.75
11	32x66	20.18	17.00	14.53	16.68	12.91	21.97	94.50
12	34x78	22.38	17.49	15.13	17.28	12.44	13.17	93.01
*13	34x78	54.33	19.30	16.37	18.35	10.79	16.41	95.34
14	34x66	29.64	17.19	14.56	16.63	12.46	22.82	94.09
15	34x78	35.32	18.14	15.48	17.40	11.08	17.10	94.00
16	32x66	20.48	16.97	14.47	16.41	11.82	13.63	93.63
17	32x66	24.49	17.60	14.78	16.62	11.12	24.63	93.84
18	32x66	23.24	19.04	15.95	18.26	12.69	7.18	93.65
19	32x66	21.20	16.85	14.69	16.66	11.87	22.88	92.46
20	32x66	18.14	16.98	14.48	16.36	11.49	15.65	93.13

It will be seen on examination that the polarization of the true cane juice as compared with that extracted by the first mill varies within wide limits:

In No. 1 the difference is 17.73—16.26=1.47
" 4 " " " 19.00—18.17=0.83
" 13 " " " 19.30—18.35=0.95
" 19 " " " 16.85—16.66=0.19

What causes these variations in canes at different places? and why should there be so small a difference between the two juices in No. 19, which is a factory on Hawaii, while No. 1, which is a factory on Oahu, shows a difference of 1.47, being 7 times as great as the former one.

It is the opinion of your Committee that this point should be referred to the Director of the Experiment Station for investigation, as it is very clear that the kind of cane we should grow, other things being equal, is that in which the true cane juice approaches most nearly in richness to the juice extracted by the No. 1 mill in our factories. A general survey of the figures is gratifying to those interested in the progress of improvement; an average extraction of 93.79% of the sugar in the cane is certainly a

*No. 13 is a 12-roller mill and it is of interest to note the large quantity of cane put through per hour, the small quantity of maceration water used, and the high extraction obtained.

step in advance; still further improvement is promised in the extended use of the 12-roller mill, which has proved itself during the last crop and will be in operation in three or four factories for next season's grinding.

FILTRATION OF SCUMS AND SETTLINGS.

As the member of your Committee to whom this section was referred, has not reported, the following may be interesting. All factories use filter presses, but very few get good results, the average loss of sugar in press cake reaching from 6%—9% on its weight. There are, however, three factories which reduce the sugar in the filter press residues to very low figures, from ¼ of 1% to ½ of 1% of sugar on the weight of the cake being lost.

This is accomplished by washing the press-cake in the presses by hot water under pressure, and is practicable for all factories using filter presses which are constructed in such a manner as to admit of this operation, (all modern presses are made in this way). Fairly good results can be obtained by double pressing the filter press residues, but this requires a double battery of presses, more men, more filter cloth, and does not produce as good a result as by washing in the press, but considerably better than by single pressing without washing; the loss by double pressing amounts to from 1%—3% on the weight of the press cake.

The only improvement in view in filter press work is an extension of the plan of washing the cake in the machines after the first pressing.

PREPARING PRODUCT FOR MARKET.

At the time the special report on this subject was written the marketing returns had not been received so that a statement as to the keeping qualities of sugars prepared for market in different ways could not be submitted.

The following figures are, however, now available; A and B are figures from two plantations which use Hersey granulators or driers, and C are figures from a plantation which does not use the granulator:

	No. of Bags.	Shipping Weight per Bag.	Shipping Polarization.	Landing Weight per Bag.	Landing Polarization.
A	399.600	112.26 lbs.	97.306%	112.23 lbs.	97.06 %
B	not given	111.111 lbs.	97.228%	111.29 lbs.	96.65 %
C	619.684	125.00 lbs.	96.74 %	124.34 lbs.	96.236%

For A and C the returns include the drop in polarization due to fresh and salt water damage and sweated sugars in all the cargoes. It will be seen that the sugars A and B after being passed through Hersey driers apparently kept very little better than C sugars which did not pass through granulators or driers. The main difference is in the landing weights of the sugars, but this is not necessarily due to the action of the Hersey driers, as sugars damaged by fresh or salt water always lose in weight.

The moisture in the A and B sugars on leaving the factory was about .35%, the moisture in the C sugars in leaving the factory averaged .7%.

It is very doubtful if it pays to reduce the moisture in shipping sugars below .5% since both sugar crystals and the molasses adhering to them are slightly hygroscopic, and will attract moisture from the atmosphere if shipped in a very dry condition.

WASTE MOLASSES.

The average point to which the waste molasses has been reduced is low, averaging 30.14% direct polarization and 34.3 apparent purity.

By referring to Dr. Maxwell's Report for crop 1895 it appears that the average of 20 plantations then reporting made 35.4% direct polarization and 46.5% apparent purity, showing that considerable improvement in this work has taken place.

Most unusual results are being obtained in this work at several mills on the Island of Hawaii and Your Committee understands that the Director of the Experiment Station is about to undertake a series of tests of waste molasses to determine, if possible, the minimum figure which may be reached in the different districts. In conclusion your Committee hopes that the system of exchange of reports begun this year may be continued, and that for next season a final crop statement may be rendered by each plantation in the exchange, as the figures are of great value to all engaged in the industry, since it is only by exchanges of figures and ideas that substantial progress can be made.

Respectfully submitted,

J. N. S. WILLIAMS,
Chairman.
E. MADDEN,
WM. STODART,
E. K. BULL,
J. A. SCOTT,
J. WATT,
Committee on Manufacture.

The Chairman—Gentlemen, this report is open for discussion. I would like to say in connection with Mr. Williams' report that at the first part of last year's grinding season, the price of sugar was considerably different from previous years. I asked him to figure out the polarization that would pay us best at that price of sugar, which, as you know, was above four cents delivered in New York, and also the polarization which would pay us best to deliver in San Francisco. You will undoubtedly know that the New York contract differs from the San Francisco contract. The New York contract, in a general way, calls for the higher grade of sugar, or, I think we could very properly say, encourages us to make a higher grade of sugar; whereas we could ship lower grades of sugar to San Francisco with profit. I wanted to know what effect the price of sugar had on both of these contracts. Mr. Williams figured it out and I also asked a party not connected with our plantation to do so who is pretty high up in calculations of that sort. It is not a very simple proposition—not as simple as a person might think—for you have got to take into account several things in connection with it. His figures were practically like those of Mr. Williams. When it came to write out his report, Mr. Williams asked me if he should publish it, and there were reasons why I thought he should not publish the whole thing at that time. He brings out the question of waste in molasses very clearly, as you can see from his figures. I do not mean to assume but what all the planters present here, as well as the chemists also, have figured out this matter in connection with their crops. I mention the matter because I know of one plantation which did not do so. As it is a prominent plantation, I will not mention any names; but I know that they lost a lot of money by not figuring it out. Our figures show that for the high prices we had, notwithstanding the New York contract, encouraged sending as high-grade sugars as we could,—say as high as 98—that it paid us to send a sugar which polarized as low as 96 to New York. Of course everybody knows you have got to allow at least from one-fourth to one-half of one per cent. for deterioration in sugar. Hence, as I remember, (I have not got the statement here), it would not have paid us to have sent a lower grade of sugar than 96 to San Francisco. This year, however, under the prices we are starting out with, and according to the formulas which they worked out, it will pay us to ship a high grade of sugar to San Francisco, in fact as high as 96 to 98.

I allude to this because Mr. Williams has only partially given it in his report here. The view that I take of it now is that there would have been no harm if we had published the whole thing; and I will say that if the planters want the result of our figures on the subject, I would be glad to send it to Mr. Mead and have it printed and distributed.

Mr. E. E. Hartmann—I had some correspondence with Mr. Williams on this subject, and we did not exactly agree. Mr. Williams in his calculations assumes that the moisture in all sugars, whether of 90 or 99 polarization, is the same. Yet we all know that the higher the polarization is, the less moisture the sugar, other conditions being equal, will contain, particularly if the sugars are not dried. If the sugar is three cents, there is a dollar in favor of the 98 polarization; if four cents, about half a dollar; while at five cents there is an advantage of 13 cents in favor of 96.

The Chairman—You mean for the New York contract, do you not, Mr. Hartmann?

Mr. Hartmann—Yes, for the New York contract. Of course there is a difference whether the sugar is dry or not. I have made two sets of calculations. Undried sugars of 96 polarization I have assumed to contain 1.2%, undried sugars of 98 polarization .7% moisture, while for 96 polarization dried sugar I assumed the moisture content as .4%, for 98 polarization dried sugar .3%, figures, which fairly represent the average of practical work. The true purity of the waste molasses I assumed to be 40. This is below the average, but it represents about the best work done. The total average cost of containers, freight and charges I took to be $15.00 per ton of sugar shipped to New York.

I found the following differences per ton of sugars in the juice:

New York Basis.		In Favor of 98 Pol.	In Favor of 96 Pol.
3¢	Undried	$1.08	——
4¢	Undried	$0.47	——
5¢	Undried	——	$0.13
3¢	Dried	$0.96	——
4¢	Dried	$0.29	——
5¢	Dried	——	$0.38

This means, that, as prices are likely to run for the coming season, we can realize from 50¢ to $1.00 more per ton of sugar extracted from the cane by shipping the sugar with 98 polarization, than we would if we shipped 96 sugar. I pointed out these differences some two or three years ago, and the rough calculations I made then, led to practically the same result, except that too high a figure was found for the difference in favor of 98 Pol. The figures, I have just read, take everything into consideration. It was Mr. Williams, who drew attention to an omission in one of my earlier examples.

The Chairman—I think that Mr. Williams first figured it out roughly, when I told him I wanted the figures, and possibly the figures he handed you were the rough ones. I know, however, that he afterwards went into it thoroughly. It is an important subject, and I would say in this connection that my opinion is that we should all, as far as possible, ship one grade of sugar and keep it that grade of polarization, as near as we can, (of course we can not change it very much) according to the price of sugar.

I would be willing to send in the result of our figures to any one desiring it, so that they can compare it with their own figures. It is a good thing to compare results of that sort.

Are there any others here who would like to discuss any other parts of the report of the Committee on Manufacture?

Mr. Renton—Mr. Williams says (reads):

"It is very doubtful if it pays to reduce the moisture in shipping sugars below .5% since both sugar crystals and the molasses adhering to them are slightly hygroscopic, and will attract moisture from the atmosphere if shipped in a very dry condition."

The Chairman—Mr. Williams has talked that matter over with me. He means that there is no need of reducing the moisture in shipping sugars below .5%, since the sugar will draw that amount from the atmosphere anyway. His view seems to be that the Hersey Dryer very probably drys the sugar more than it needs to be.

Mr. Andrew Adams (Kahuku Plantation Co.)—We have no Hersey Dryers, so I can not say anything of my own knowledge; but on Mr. Hedemann's return from Java two years ago, I think it was, when he made his trip, he said that in Java where they use the Hersey Dryers almost universally, they found that from their experience it paid them to dry the sugars to about 4-10ths of one per. cent., that there was less deterioration at that figure and it paid them better for that reason.

The Chairman—That would depend upon the destination, across what waters they are shipped. There are a number here who will remember how difficult it was when we first started to ship sugar around the Horn in wooden vessels. The captain generally used to get a fee if he got his sugar there in good condition, and I remember very well that with our first shipments the loss was such that the next year we feed the captain to get our sugar there in good condition. We lost all the way from five to ten per cent. of the sugar. I remember that it was stated that two captains started out from Honolulu and that both of them were to have a fee if they got their sugar to New York in good condition. One of them said that every time he got a clear day he was going to open his hatches. The other said, "No, I am going to keep them closed." The one that opened his hatches on what he called a clear day, when there was no moisture in the air, got his sugar in a horrible condition, it sweated horribly. The other one, who did not open his hatches at all going through to New York, found that his sugar polarized nearly as good as originally. It makes a difference where you ship the sugar.

Mr. Renton—I was somewhat struck with the statement here on page 14 of this report that "all factories use filter presses, but very few get good results." At Ewa Plantation, the sugar boiler, Mr. T. O'Dowda, about a year ago hit upon a very good method of washing the sugar in the presses by hot water under pressure. I have in my pocket the rules for working the presses, and I think it might be a benefit to hand these rules to the secretary to be printed with the report.

FILTER PRESS RULES.

By Thos. O'Dowda.

(1) Keep grooves clean in press frames. (It is not necessary to have screens or plates on filtering frames.)

(2) Keep all parts of the press clean.

(3) Keep a tank for water, so that in pumping water for lixiviation or washing cake, a strong even pressure may be kept on the press. Use a Marsh pump with hot water from the evaporators. Pressure on presses 50 pounds in washing cake. Be sure and keep good pressure on.

(4) Water from washing press cake to be run into a tank and pumped from thence into filter press supply tank, to dilute the skimmings and settlings.

(5) When washing out the cake (or lixiviation) open inlet from pump, leaving all press faucets open and running free for about five minutes. This cleans all channels, and everything runs free; then gradually close faucets until every one is almost closed, but not quite. This is to be kept up for say 25 minutes.

(6) Water to go in the same inlet as the filter press skimmings.

(7) Steam is let in the same inlet as the skimmings.

(8) After washing or lixiviating with water, open all faucets wide; then turn on steam at 110 pounds pressure for say 10 or 15 minutes. If pressure is lower, then keep steam on longer.

(9) Drainage from steam washing to run into same tank as drainage from washing by water.

(10) Have two outlets in all troughs—one for filter press juice to evaporators, the other for sweet water to tank, with which to dilute scums.

(11) Cloth used in filter presses is of No. 6 and No. 10 grade. No. 6 for small presses and No. 10 for large Kroog presses.

(12) Use Monte-Jus for forcing skimmings to presses. It is surer. Pressure, 25 pounds.

(13) In taking samples of press cake for analysis, empty entire, mix it up with a shovel, then take a sample of the mixture and analyse for sugar at once.

(14) There are four kinds of presses at Ewa: 8 small Kroog presses, 3 large Kroog presses, 8 small Honolulu Iron Works presses, 9 small Honolulu Iron Works presses, new pattern—G. F. R. Of these the large Kroog presses give the least satisfaction. They cannot be kept tight enough under water pressure in washing, to thoroughly remove the sugar.

The small Kroog press and the small Honolulu Iron Works press are about even in their work.

The latest Honolulu Iron Works press, made under instructions from G. F. R. for E. P. Co., works the best. In this, however, the skimmings and lixiviation water are run in at same inlet. The steam goes in both inlets as made. In this press day after day press cake has been analysed and no sugar whatever shown.

(15) For filling presses with skimmings, no special treatment is used. Send in first at low pressure then increase to 25 pounds. When press is full begin lixiviation as above.

(16) Use two thicknesses of filter press cloth on filter frames.

(17) Use between four and five pounds lime per ton of sugar in the skimmings. Lime juice slightly (very) alkaline.

Keep presses clean and pump water under pressure.

Mr. Hartmann—I have heard about this way of working and would say that Mr. Messchaert at Waipahu has made a comparison between re-melting the cake and washing it in the presses. He came to the conclusion that the latter method, that is, the one they use at Ewa or some similar one, is preferable. The purity of the lixiviation water is higher if the cake is washed in the presses than if it is re-melted. I believe Mr. Messchaert's results are embodied in a paper to be read before the Hawaiian Sugar Chemists' Association.

The Chairman—Mr. Williams has reduced down our mud press cakes to about one and a half per cent. Our conclusion has been that it is entirely unnecessary to re-melt it.

Report of Committee on Labor Saving Devices.

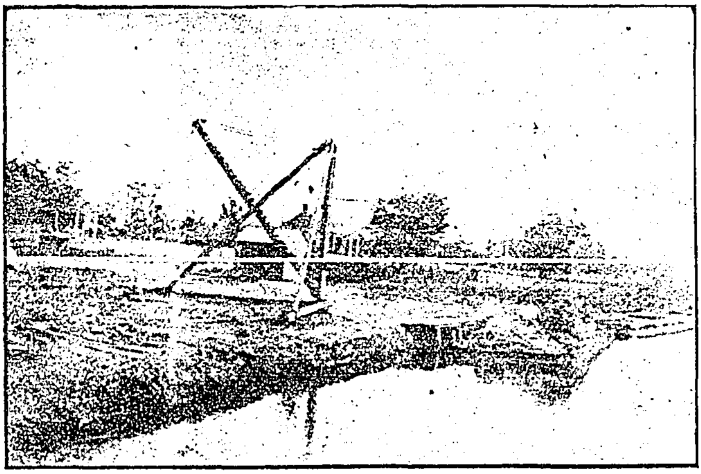
To the President and Members of the Hawaiian Sugar Planters' Association, Honolulu, H. T.

Gentlemen:—My reappointment to the Committee on Labor Saving Devices so late in the season finds me with little new data, as the correspondence being carried on at the close of last period with the patentees and persons interested in cane harvesting machinery and manufacturing concerns of similar machinery, was discontinued, and such new data which I here present has been gathered from trade journals and advertisements. The all important subject for this Committee's consideration is that of cane harvesting machinery, which, at the present time assumes greater importance than ever, because of the increasing scarcity of field labor for such work.

I am, therefore, omitting all reference to other labor saving devices which may be valuable in a small way, but do not affect the most vital question before us,—"The Labor Situation." In connection with this I venture to say that the scarcity of this class of labor will, during the coming crop, directly and indirectly, cost many of the plantations of these islands several thousands of dollars.

CANE LOADERS.

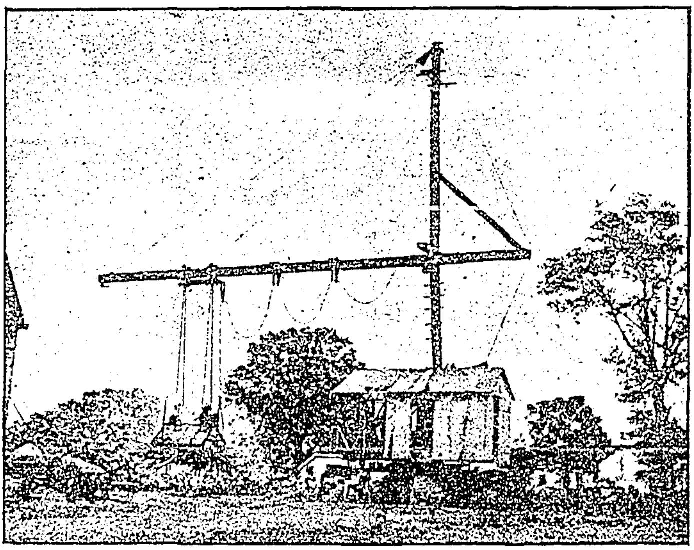
If the Executive of this Association would agree to appropriate a few thousand dollars to be used first towards perfecting and putting in operation a machine for the loading of cane of a design for the picking up and continuously elevating the cane; a device that would do away with the entire hand labor; one that would



OLD-FASHIONED HORSE POWER.

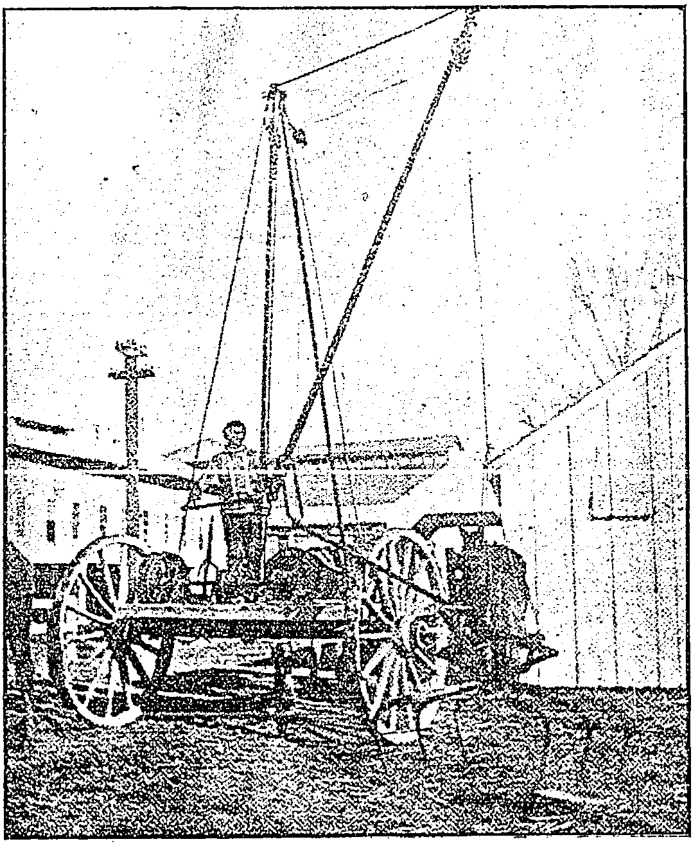
pick the cane from the ground and elevate it into the wagons, similar to the old style header machines which deliver ears or heads of grain into header wagons from whence it is hauled to a thrashing machine, so that the operation would be practically the same, wagons driving alongside to receive the cane and from there taking it to the main lines of railroad or main lines of flume, where stationary cranes could be arranged at different stations, or where large portable steam crane hoists on cars or on wagons might be placed for the purpose of transferring the loads to the cars or to flume platforms; even if at first a device of this nature had some minor defects such as failure to do perfect, clean work, leaving some scattered canes and the picking up of some trash, then something would be accomplished. By this I do not mean to take up every patentee's petty device, but I would like to see responsible manufacturing firms encouraged to make experiments whereby their apparatus might be adapted to our needs. A machine of this nature would displace hundreds of hand unskilled labor on each plantation, thereby replenishing the supply for other work. It would increase the semi-skilled labor and number of mules in service without increasing the cost. Machines which do not automatically pick up the cane as labor saving devices are of small benefit to the present labor problem, for the fact remains that hand labor is necessary with the device.

Cranes similar to what is now being used throughout the Islands and erroneously classed as "cane loaders," when in point of fact they are only mechanical devices for transferring the cane, which, in all cases has been gathered, assembled and bundled or loaded by hand into vehicles of some kind, only perform one-half of the work.



STEAM BOOM CRANES.

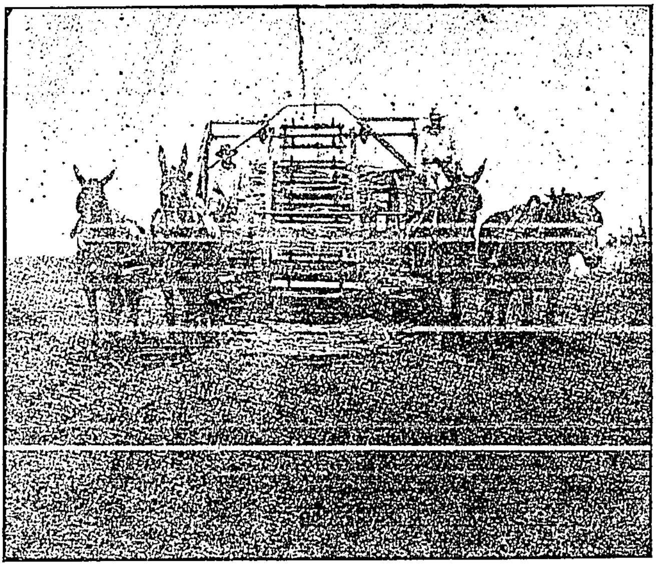
The "cane grabs" extensively used in Louisiana for the grappling of cane when transferring from scows to cars, and cars to the mill carriers by the old-fashioned horsepower stationary derrick and the modern figure 4 steam derrick, because of the massive structure of both derrick and grapple gear, are proven long since an economical success. Along these lines many of the planters of Louisiana have devised boom derricks rigged on wagons, light and portable, with the same grapple gear on a smaller scale, for grappling the came bundled or gathered by hand on the ground, transferring same to wagons.



GOETZ CANE CART LOADER.

A recent speed test of several machines of this type, in Louisiana, showed that the Goetz Cane Cart Loader was lighter and more portable, and had some advantages.

The Louisiana planters are, however, still awake to the necessity of a labor saving device that will cover the entire field, and eliminate the labor necessary to gather, bundle and pick up the

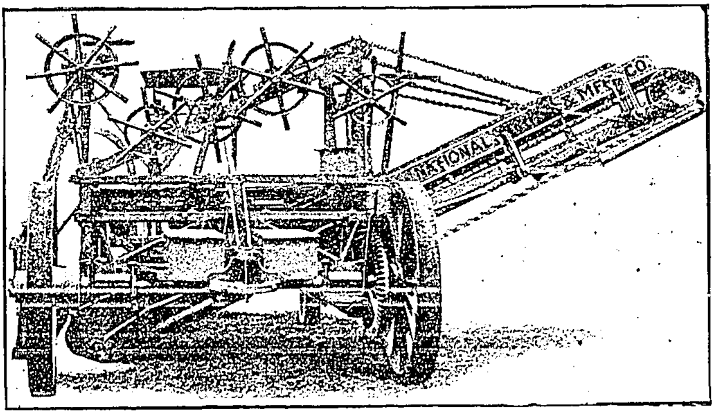


MARTINEZ CANE LOADER.

cane; in fact, they are figuring on a combined device for both cutting and loading of cane. One of their planters writing in the issue of October 7th of the Louisiana Planter and Sugar Manufacturer, in calling attention to their scarcity of labor for the harvesting of the coming crop, estimates an expenditure will be made of over $50,000.00 for recruiting labor, and then the labor demand will not be satisfied, and losses will be made by planters in not getting in their crops in time.

He strongly urges upon their association, that at least one-half of such a sum be used in devising a harvesting machine that will be such a labor saving device as will do away with hand labor.

The "Martinez" Cane Loader which picks its cane up from where it had been laid at right angles to the furrow by the cutters and elevates it to a table from where it is swept by a revolving



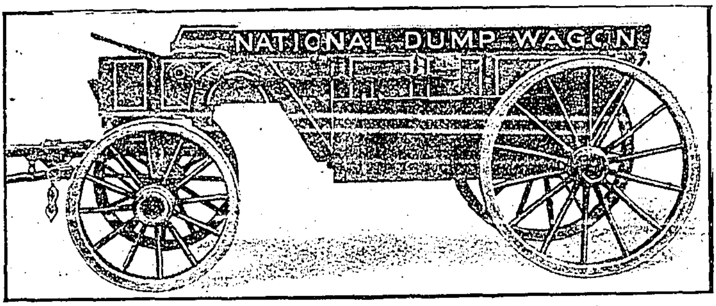
NATIONAL DRILL & MANUFACTURING CO.'S GRADER AND ELEVATOR.

arm and slid into a cane cart or wagon driving alongside, is daily gaining in favor as the only practical cane loading machine in the field. Mr. J. D. Martinez is the Manager of the Alhambra Plantation and has lately made some improvements in his device by operating some of the mechanism with a gasoline engine, permitting a lighter running gear and doing away with some of the animal power. He advertises as follows:

"One man operates it. Four mules pull it. Capacity limited only by the rapidity with which the carts can come to get loads. Strong, durable, self-regulating. No wires or ropes to break and get tangled. Weighs no more than a loaded cane wagon. Operates in any kind of weather, and picks up any kind of cane."

The National Drill & Manufacturing Company are one of the several concerns in the eastern states who are manufacturing successfully elevating machines which handle gravel, boulders and dirt, and load it into their bottom-opening dump wagons, known as the National Dump Wagons.

In line with my opening remarks I feel that if the Executive of the Planters' Association would lend proper encouragement or inducements by offering to pay a part or all of the expenses incurred in remodeling a machine of the above type, that valuable results would be obtained quickly, as the builders of such machinery have already solved and perfected nearly all of the problems that will be met with in our work. They specify that one of the advantages and essential features in the construction of their elevator grader is the provision which is made for the tightening of the elevator belt particularly in case of working in wet, slippery soil when loading wagons.



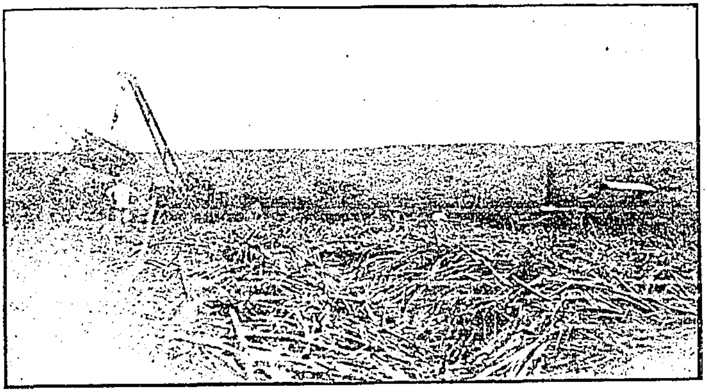
NATIONAL DUMP WAGON.

(The above cut gives view of wagon showing doors sliding up the outside of box, the dumping operation being performed by driver from the seat.)

The Honolulu Plantation Company have ordered one of the National Drill & Manufacturing Co.'s bottom-opening goose-neck wagons having a total height of 57 inches over all, which will be tried in the carting of cane to its transferring goose-neck crane, instead of sleds as now used; experience having taught that an arrangement for a cart or sled to dump its load immediately upon arriving at transfer station that a saving of time could be affected.

We believe it will be possible to dump a load of cane with our spring bottom-opening sling in place, which handles 1500-pound bundles; thus the bundled cane can be left within reach of the derrick without detaining the wagons, otherwise any ordinary dump cart would answer, as the cane could be dumped in a loose pile where it could again be picked up with the large grapple forks heretofore mentioned as in use in Louisiana in handling of cane by a steam derrick.

Steam plows were used by this company in some of the side hill fields for the conveying of cane to a transfer station where our

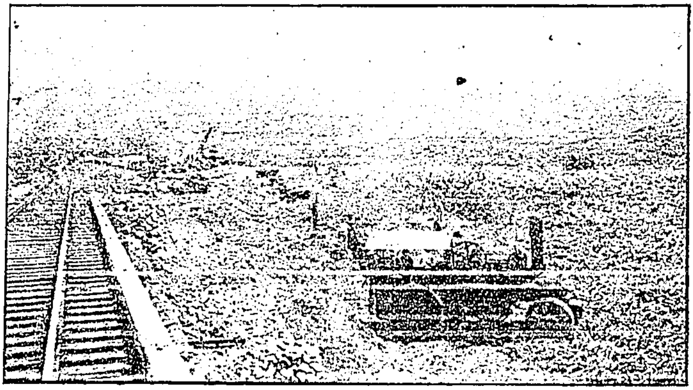


DERRICK WITH SLING LOAD OF CANE.—H. P. CO.

goose-neck crane was located (cut on following page shows a string of loaded sleds attached to the traveling cable, conveying cane to a transfer station, length of haul over 1200 feet).

The sleds as they were loaded were attached to the traveling cable by self-tightening cable clutches somewhat similar to the cable clutch used on cable cars. From 20 to 25 cars of cane per day (ranging from 70 to 90 tons of cane) were loaded by this method, with one overseer, five men loading and three men on derrick and cars, which is worked by mule power. Should we have had steam power on the derrick, we figure that more than double the work could have been done. The great delay was in the vicinity of the derrick. Gasoline engine for power when attached to the crane will allow the same crew to gather and load more than 160 tons of cane per day. Under such circumstances the cost would not be in excess of what we are now paying for loading by hand labor, taking into consideration the small quantity of portable track work necessary under this method. In enumerating the number of laborers we have not included the steam plow crew. Steam plows would not be necessary for this method of transporting cane, yet, however, the coiling devices for winding up the rope playing between the two engines is most necessary.

A few of the Wilson-Webster Wire Cable Derricks for the loading of cane similar to those which have been in use at the



STEAM PLOW HAULING CANE SLEDS.—H. P. CO.

Ewa and Waialua Plantations for the past two seasons, have been sold to the Hawaiian Commercial Company, to be used in the harvesting of their coming crop.

CANE CUTTERS.

Under the above title the Gaussiran Patent Cane Cutter is the only machine which is being marketed for this work. A device patented by Mr. Ginaca, a consulting mechanical engineer of Honolulu, is being developed. His preliminary machine for experimental purposes was tried in one of the fields of the Honolulu Plantation for the purpose of proving his theories. He is now building a second machine which will be an actual working model. We understand the Ginaca machine does not aim to top the cane.

Owing to my departure from the country for a few weeks I have written the other members of the committee if they had anything to offer on this subject, they should address you directly.

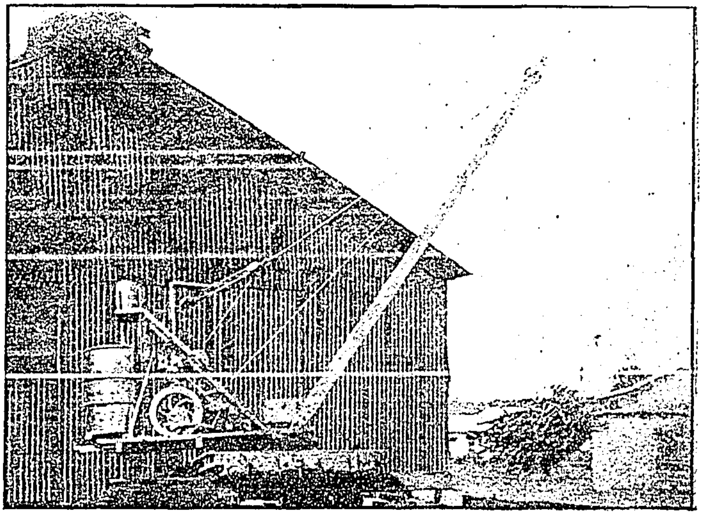
Respectfully submitted,

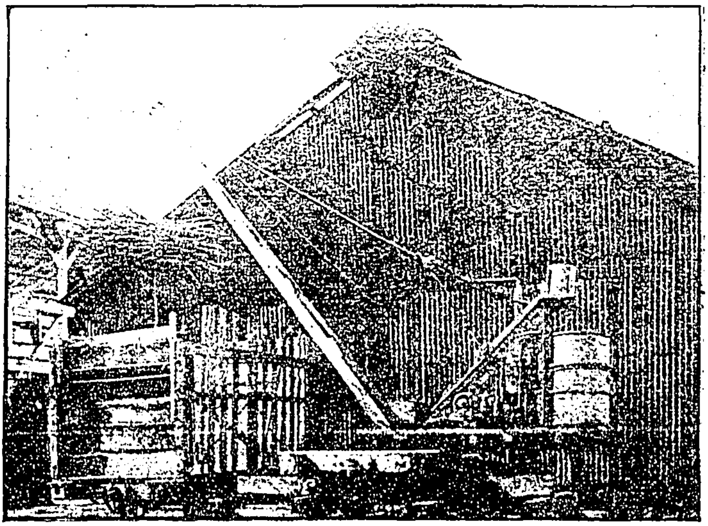
JAMES A. LOW,

Chairman Committee on Labor Saving Devices.

CANE LOADING AT WAIAKEA.

The Cane Loaders at Waiakea have done good work for the last three seasons. All of our cars are filled by the loaders, the cane being brought to the side of the railroad either by sleds or low trolley carts. We haul the cane between 500 and 600 feet, as the case may be by mule power, and having no port-





able track, (speaking as the term is used on plantations where that system is carried on) we shift our track, but always see that the road is good for locomotives.

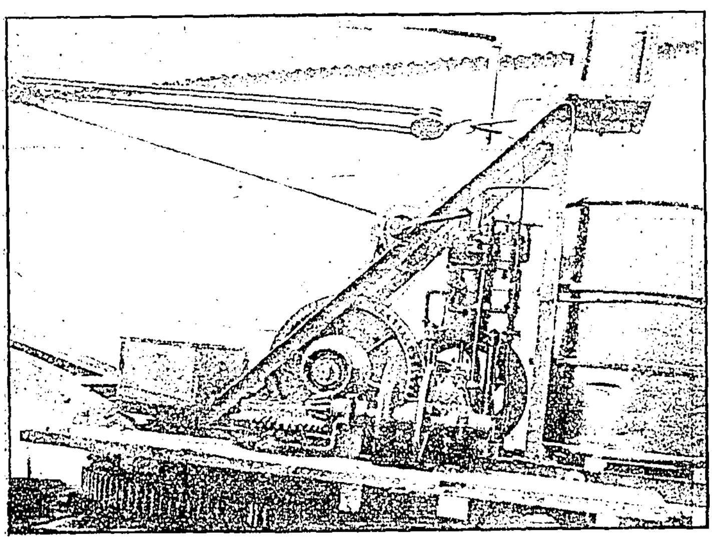
Our cane is picked up loose and placed on sleds or trucks with a sling under the cane, and after that it goes to the side of the railroad and the thing for the loader to do is to take the cane and put it into the railroad cars. This is done by our loaders which are on a side track parallel with the main line about 7 feet from each other.

Capacity.—To give the capacity of one machine, (to pick this cane off the trucks and drop it into the cars) is to state that I have known one to load 300 tons of cane into cars in 9 hours with 3 men all told, working slings and emptying same, (one man easily works the machine).

The regular amount loaded is 200 tons.

Fuel.—It will use 5 gallons of distilate per day, costing us 17 cents per gallon.

No trouble is experienced for water for cooling of the cylinder as the same water is used over and over all day and does not require renewing for weeks, especially in the Hilo district



where it rains considerably, the water being caught from the roof of the house over the loader.

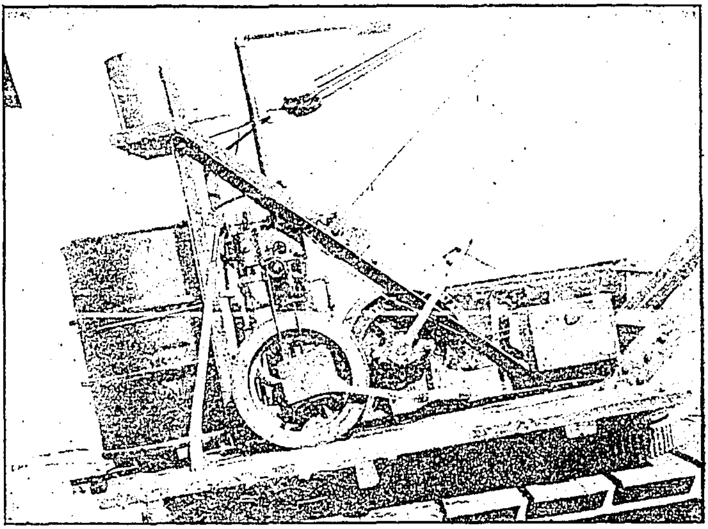
Shifting.—To shift the machine is an easy matter—no difficulty whatever, since it weighs but 2400 lbs. Thus any Portuguese after a little experience can do it, and not requiring a special man for the purpose.

Labor Saving.—We claim a saving of 60 men a day on Waiakea, on 420 tons of cane handled, since we got these machines.

We use the loader to fill cars with wood or anything else as well as cane.

This machine is just like a locomotive crane running by gas. The best feature of the machine is tilting the car a foot higher at one end, thereby the crane is made to work twice as fast as if it were on a level.

Balance.—To balance a load of 1200 to 1500 lbs. of cane have the engine and the water tank adjusted so that when the weight of



cane is hanging on the crane, the cane is the heavy end, and being the heaviest will naturally work down hill easier on the car. When the cane is dropped the tank end is the heaviest, and of course, it wishes to get to the low end in a hurry. So on it goes, first the cane is the heaviest, and then the tank, time about, thus making it self acting.

Slings.—With the loaders, the slings are as important, so that as soon as the load of cane is over the car, and in position, the little cord hanging down is pulled and the sling opens in the bottom, one-half going each way, hanging on to the lifting rope.

Improvements.—After three years we have not been able to improve on the machine.

Engine.—We use the Union Gas. Engine, and find it all we need to do the work, and gives no trouble.

For picking up cane and filling cars, I have not met its equal. As for hauling cane to the track, we claim nothing in that line, but for a loader I say this machine will do the work. Our loader is for that purpose only, and have not tried to make it do the hauling of cane, our mules doing that at present.

We are now making a machine half the weight of our present loader, to be placed on truck or cart to pick up cane in the field and place it on truck, to be taken to the larger loader along side the railroad.

This light machine will not have a water tank for cooling the gas. engine which will make it a very light one to cart in the field, we believe four of such will do our work and make a saving of 3 cents per ton of cane.

There is nothing like trying, what are the most of you doing on the Islands? standing back, waiting developments and laughing at failures?

Let us keep at it, gentlemen, and we will get there, but all get to it. One machine may suit one, and not suit the other. Make up your minds to try something, then work on it till you succeed, for you will never gain success until you do try.

C. C. KENNEDY.

The Chairman—Our plantations have been considerably alarmed over the fact that so many of the strong Japanese—who principally do our cane loading—have left here to go to the Coast. They are called away for pick and shovel work in the mines, tunnels, and railroads, and we have turned our attention considerably to the subject of cane loaders.

I purchased for our plantation several years ago a cane loader invented by a young man by the name of Ricker. The cane loader he got up was really practicable; but for lifting around, it was too heavy. It weighed about ten tons, having oil for its power, and was too heavy for our portable tracks. It was also a little clumsy to handle and we gave it up.

We have lately purchased three of the Wilson-Webster cane loading machines for the Puunene plantation and two of the Kennedy machines. The Kennedy machine is almost exactly like the Ricker machine, except that it is light, weighing something under 1800 pounds, as against ten tons for the Ricker machine. We will try both. Probably one will be tried at the Haiku Sugar Company and the other possibly at Puunene. Mr. Taylor, our engineer at the mill, thought that he could work this grabbing principle to advantage and we gave him a chance and he made a grabbing machine; but the trouble was that it would grab up too much trash and would leave too much on the ground, and we abandoned the idea. I do not see how it would be used to better advantage in Louisiana than it could at the Haiku Sugar Company. I think Mr. Renton and Mr. Goodale, if they were here, could tell us something about cane loading machines, and I think it would be of benefit to hear from them.

Mr. Renton—We used the Wilson-Webster machine on the Ewa plantation for a considerable period during 1904. It was found at that time, after I presume two months' work, that there was sufficient in them to warrant the purchase by the Ewa Plantation Company of three machines for the following year. These machines were not delivered to us as promised at the beginning of the crop, but were delivered at different times during the season, and we found that they were built much too light. We were green, of course, at handling them and the cost of loading during the first month or two was very high, in fact each machine had to be taken to the machine shop at the plantation and practically rebuilt. Nevertheless, their work has been such that I came within an ace of recommending an entire equipment for the plantation because of the reasons stated by Mr. Baldwin. I halted only for the reason that I wish to try one or two of the other loaders before taking on myself the responsibility of recommending on behalf of the plantation an order of that size. The last two months at Ewa, the Wilson-Webster machines did remarkably good work. When we hired the man to do the bundling by contract, it was fully as cheap as the work performed by the Japanese contract laborers by hand. The machine I think could be improved in several ways. It should be a little longer, fully thirty per cent. heavier, and a machine with a corresponding increase in strength. Instead of fifteen horsepower as they have now, I would recommend a twenty horsepower. Owing, however, to the representations made at the last meeting by those who favored the Kennedy machine, I halted before purchasing more of the Wilson-Webster loaders, as I understood that the Kennedy machine was capable of loading 300 tons of cane per day. This the Wilson-Webster machine can not do. It is a very large quantity, however, to be handled by one machine; I do not see quite how it is accomplished. I noticed, however, in the report of Mr. Kennedy on "Cane Loading at Waiakea," that the regular amount loaded is 200 tons, which is very good work indeed. I tried to get the men to load by contract, that is, pile it in bundles. The rest of the work is performed by day labor. Under these conditions, the loading machines—Wilson-Webster—did remarkably good work at Ewa during the last two months of the crop. I did not feel like giving the whole thing out to contract, because it requires skilled labor or semi-skilled labor to handle the machines, and we considered them too valuable property to place in the hands of contractors who may leave the place. They are irresponsible.

Mr. Kennedy—We have a machine now that is being built in

San Francisco which we figure will be carted through the fields with two animals and that we will pick the cane up and load these trucks that are about two feet higher than the sleds and do away with quite a lot of the hand labor. In Louisiana they claim that they can lift the cane for four cents a ton. tI has been costing us about eight cents to lift it and put it on these sleds and carts. Now, if the Louisiana people can do it for four cents, I am satisfied that we can do it for four cents. I sent to Louisiana and I got one of those machines to experiment with. But I found that it was such an old thing and so much of a back-woods business, that I would not touch it. It is now in my yard as a monument. I may get some points from it, but I would never think of using it.

Mr. Thurston—I have never seen the Wilson-Webster machine at work, but I have seen Mr. Kennedy's machine work, and at the adjoining plantation, Olaa, we have been so much impressed with it that we have ordered three machines for this coming crop and they are now about to be delivered. I think one of the chief points with Mr. Kennedy's machine is a point which was developed accidentally after it was in operation, of setting it on an angle instead of having to turn it around by power. It swings around of its own weight. That is spoken of by Mr. Kennedy in the description of his machine, but it seems to me that that point ought to be emphasized, because it is one of the chief points of the machine. When the load is on one end, that becomes heavier and naturally falls down towards the car; as soon as the sling has been dropped, the power engine, which is on the other end of the machine, then becomes the heavier end, and the derrick goes back to its original position. So that it works automatically without any power, and there is no time taken up; it is a sort of an oscillating motion. I think that is responsible for the large amount of cane which is handled in a day or in a given time, which appears to have been a surprise to Mr. Renton.

Mr. Renton—The advantage mentioned by Mr. Thurston is not alone confined to the Kennedy machine. The Wilson-Webster machine is run in the same way exactly, the only difference between the two machines that I can see being that Mr. Kennedy has one crane alongside the track and the Wilson-Webster machines have two cranes, and furthermore, in addition to this, it pulls in the cane fro mthe fields and does not have to depend upon mules.

Fighting Insect Pests with Insects.

By Alexander Craw.

On November 22, 1905, the following paper was read before the Hawaiian Sugar Planters' Association by Mr. Alexander Craw, Superintendent of Entomology for the Territory of Hawaii:

Mr. Chairman: At the request of Mr. Swanzy I herewith present a short paper that may be of interest to the members of the Hawaiian Sugar Planters' Association and others engaged in the agricultural and horticultural industry of this Territory.

I am given to understand that a few years ago Hawaii was free from plant pests and blight. Roses, pinks and other choice flowers, could be gathered in abundance, free from blemish, although our flower stores, markets and venders even now have always a liberal supply and are famed for their wealth of flowers done up into bouquets, leis and other floral devices to decorate our departing or returning friends. This is a beautiful custom and peculiar to Hawaii. It is no unusual sight to see the native men and women going to work or business with their favorite flowers encircling their hats, or necks. We naturally feel grieved for any injury done to the beautiful in nature, but when the financial interests of a community are affected by such imported insect pests and blights, efforts are immediately devised to exterminate them or control their destructiveness. This has usually been a recourse to insecticidal solutions in the form of sprays, or poisons applied to the infested plants, or by covering the trees or plants with an air tight tent or canvas and applying the necessary amount of hydrocyanic acid gas. In the case of nursery stock or imported trees and plants they are fumigated with the above gas, or the fumes of carbon bisulphide in specially prepared fumigating chambers, or boxes; such treatment is usually efficacious except in the case of mining or boring insects and all such infested stock is condemned and destroyed by burning.

The above are the usual artificial methods of insect control, but nature has a cheaper and much more effective method that in recent years has become recognized as the most rational and feasible way of fighting our insect enemies, and that is to send experts to the native habitat of the pest and there study up the parasitic checks to such pests. These again unfortunately have what are known as secondary parasites that prey to a certain exten upon the primary species, and these the experienced collector guards against by breeding them out before sending, or cautions the entomologist at home to see that none issue and scape from the breeding jars or cages. In some cases at least fifty per cent. of the beneficial insects are thus destroyed, so when we obtain the parasites without this check we are more successful with them than they are in their native country.

Dozens of species of formerly destructive insects can be enumerated that have been brought under subjection by parasites or predacious insects, and once introduced are no further expense to the orchardist or planter. The introduction of insects that attack other insects can never become a pest to vegetation any more than a tiger can become a ruminant, so must have the insects upon which they prey to exist. In this method of warfare against insect pests we do not look for extermination, but rather to keep in check their destructive numbers.

The introduction of *Vedalia cardinalis* into California from Australia and later into Hawaii, South Africa, Portugal and Florida from California to prey upon the "white" or cottony cushion scale, was considered by several of the foremost entomologists as "an extraordinary case and would probably never be again repeated." The fact of the matter was that the *Vedalia* only confirmed and strengthened the faith of the advocates of nature's methods, who observed former beneficial results from parasites and predacious insects. Mr. Ellwood Cooper, State Commissioner of Horticulture of California, was one of the strongest advocates of fighting pests with natural enemies, and has urged upon the legislature of that State to make appropriations for conducting the search for more. In this he has been ably supported by the fruit growers, who recognize the value of the work to the State's principle industry. Compare California and Hawaii's policy with that of Massachusetts. The latter has spent millions of dollars in a futile effort to stamp out the "Gipsy" moth that was unfortunately introduced from Europe. It spread destroying not only fruit trees, but ornamental plants, shade trees and even forests. Notwithstanding the expenditure of vast sums of money the authorities were unable to even check its spread. An effort is at last to be made to introduce and spread its natural enemies, and if intelligently conducted cannot fail to be a success. It is hardly necessary to enumerate the various beneficial insects that have been introduced and the wonderful work accomplished by them. The *Cryptoloemus* introduced by Prof. Koebele saved the coffee and other plants from destruction as effectively as the *Vedalia* saved the citrus industry, and the *Rhizobius ventralis* practically stamped out the "black scale" (*Saissetia oleae*) on the Islands and the *Scutellista cyanea* is rapidly doing the same in the olive, lemon and orange groves of California. The "Codlin moth" that was introduced into the United States from Europe and now causes an annual loss of millions of dollars to the apple and pear growers of the country, may be checked by a parasite recently introduced into California from Southern Europe by George Compere, beneficial insect collector for California. This parasite is reported to be breeding freely, not only in confinement, but also in the orchards of that State. Mr. Compere is at present traveling in China to secure the parasites of the "purple scale" that is known to keep that pest in check there. If he succeeds we will undoubtedly secure colonies from Mr. Cooper.

I will now briefly mention one or two matters that will more especially interest our own people. The sugar planters too, well know the destructiveness of the "leaf-hopper" that was said to have been introduced from Queensland only a few years ago. Matters became so serious that the Hawaiian Sugar Planters' Association and the Hawaiian Territorial Board of Agriculture and Forestry determined to send two experts to search for its parasite. Professors Koebele and Perkins were selected and commissioned to carry out this important work They sailed from Honolulu on May 11, 1904. In August and September we began to receive consignments of lady-birds that they found feeding upon aphis and scale insects which were liberated on cane aphis, and others bred in confinement. During this time Messrs. Koebele and Perkins were conducting close observations and breeding out internal parasites of the "cane leaf hopper" to ascertain if there was any danger from secondary parasites and then began to collect and ship material to Honolulu. The preliminary shipments were not in good condition and no parasites bred from them. However, on October 3rd, the S. S. "Ventura" arrived with several packages of material, and through the courtesy of Collector of Customs E. R. Stackable, I was granted permission to take possession of the packages, and a few days later the first of the parasites of leaf-hopper eggs began to issue, and on the 8th of that month Mr. F. W. Terry of the entomological staff of the Planters' Association and the writer took the tiny insects to the Oahu Plantation, where the manager had a special locomotive and car meet us at the depot and we were taken to portions of that extensive plantation, over their private lines, where we liberated that and later several subsequent lots. On December 28th Mr. Terry and I visited Oahu Plantation where we secured leaves infested with hopper eggs from which we bred the parasites. The following day Mr. Terry made a more extensive examination and found that the parasites had spread naturally a distance of over sixty yards in each direction from the original colonies. I suggested the immediate distribution of the parasitized material, but it was considered by Mr. W. M. Giffard advisable to defer this work until the arrival of Prof. Perkins, who was expected early in January, and as the hopper eggs were in abundance, there was no possible danger from a short delay. Mr. Perkins arrived on the S. S. "Miowera," January 12th at 7:30 p. m., having a further supply of beneficial insects and new internal parasites for the eggs of the leaf-hopper which he had cared for on the voyage. On April 5th Mr. Koebele arrived and brought several varieties of new sugar cane upon which we found some mealy bugs under the leaves and a number of "bud worms," one Bupristid beetle, also a few cane borers. I fumigated the cane. Mr. Koebele only received the cane shortly before the steamer sailed, so that he had no time to inspect it. On July 24th the S. S. "Manuka" arrived from Australia via Fiji, and Mr. McClanahan of Honolulu was a passenger thereon. In his baggage was found a piece of sugar cane on which I found a "bud-worm" that was half an inch long. It had eaten the heart out of a bud. The cane I placed in the fire on board. Mr. McClanahan said that he only brought the cane because of its extra size.

On April 20th Professors Koebele, Perkins and I visited Oahu Plantation where we found evidence of the good work of the egg parasites, they having spread from the valley to the table lands. As you are all aware, the Hawaiian Sugar Planters' Association Experiment Station entomologists have been sending strong colonies of these and other parasites all over the Territory. Mr. Perkins recently informed me that over fifty per cent. of the leaf-hopper eggs have been destroyed by the introduced parasites.

When you take into consideration the fact that all this has been accomplished within a year from the time that the first small colonies were liberated, we can reasonably look for more wonderful work before the close of another year. After that it is my opinion that the sugar-cane leaf-hopper (*Perkinsiella saccharicida* Kirkaldy) will be so scarce that no damage will result from its presence in the cane fields of Hawaii and only enough leaf-hoppers left to keep the parasites with us.

In California there were several insects attacking the orange industry which were checked by the parasites referred to in my paper, which parasites were so small it was hardly possible to see them with the naked eye.

In regard to the Gypsy Moth, a package of plants, affected by that insect, came through here a short time ago on the "Mongolia." The package was quite open, which was a risky business, so we nailed it up.

The Chairman—We fully appreciate the work that has been done with these parasites and I think they are installed on the Island of Maui. I can not say about the other Islands, but I understand that they are thoroughly installed on the other Islands, as well.

Mr. Renton—I would like to ask Mr. Craw whether I understood him to say that Prof. Perkins had stated that fifty per cent. of the leaf hopper eggs had been destroyed.

Mr. Craw—Yes, sir, he did make that statement.

Mr. Renton—In what locality is that—at the Experiment Station, or all over the Islands?

Mr. Craw—At the Experiment Station, and I understood also at Oahu plantation.

The Chairman—Could they tell what insect had destroyed the egg?

Mr. Craw—I understood from Prof. Perkins that the leaf-hopper eggs had been destroyed by the beneficial egg-parasites recently imported. He said that it was his opinion that the most beneficial egg-parasite in destroying leaf-hopper eggs, was one of those last introduced.

There was no difficulty at all in finding the parasitized eggs at Oahu plantation on the 28th of December. They were quite plentiful, and seemed also to be spread away up on the table lands.

Report of Committee on Forestry.

To the Hawaiian Sugar Planters' Association.

Gentlemen:—The time has come around to again take stock in trade, as to the status and progress, or otherwise, of foresury in Hawaii.

Naturally the chief development of the year has taken place through the Bureau of Agriculture and Forestry, although it is to be noted with satisfaction that more than one-half of its members and representatives throughout the Territory are members of this Association. A growing disposition is also being manifested both on plantations and ranches, to both establish reserves and plant trees, not only along roads and ditches, but in groves.

FOREST RESERVES.

Act 44 of the Laws of 1903, which was passed largely through the efforts of members of this Association, created the Bureau of Agriculture and Forestry. Chief among its objects are the setting aside of suitable areas and locations, both of government and private lands, as forest reserves.

During the year last past, through the procedure provided by the law above referred to, five forest reserves have been set apart: one on Kauai, one on Oahu, one on Maui and two on Hawaii.

The reserve on Kauai is in the District of Hanalei, and contains a total area of 37,500 acres. Of this area 10,990 acres are government land, and have been formally set apart in manner prescribed by law as a forest reserve. The Board is negotiating with the owners of the remainder, for its conditional surrender to the government.

The reserve on Oahu is in the District of Koolauloa and contains 913 acres all of which is government land, and has formally been set apart.

The reserve on Maui is in the District of Koolau and Hamakualoa, on the north slope of Haleakala, covering approximately 42,969 acres, of which 15,083 acres of government land have been formally set apart. Of the remainder approximately 18,000 acres are government land under lease for more than two years, which fact, under the provisions of the existing law, prevents the formal setting apart thereof for the present. This latter area is for all practical purposes reserved, however, for the leases under which it is held restrict the use thereof to purposes not injurious to the forest.

The reserves on Hawaii are first in the Hamakua District, consisting of 18,940 acres of which 17,000 are government lands, formally reserved. This reservation is the mountain section on the north side of the Kohala mountains, lying between the Waipio valley and the Kohala district.

The second Hawaii reserve is the belt of forest lying along the northeast side of Mauna Kea, extending from the Hamakua boundary to the lava flow back of Hilo. The makai boundary is at an elevation of 1750 feet at the Hilo end, extending along a gradually rising line to an elevation of 2000 feet at the Hamakua boundary. The mauka boundary is approximately along the upper line of the woods.

The total area of this reserve is 110,000 acres of which 12,771 acres of government land not under lease have been formally reserved. The other government lands within the reserve being under lease for more than two years are not available for present reservation. The great bulk of this reserve, however, consists of private land, and the public spirit and private interest of these owners must be relied upon to make the reserve effectual.

METHOD OF DEFINING RESERVES.

It will be noted that in each of the reserves mentioned, with one exception, only a part of the land within the reservation is government land, or if government land, only a part thereof is available for present formal reservation under the law.

The question has been raised as to why so-called reserves are made to cover land which is not available or obtainable for present reservation.

The reply is that very early in the work of setting apart reserves, the owners of private lands involved did not want to agree to set apart lands for forest purposes or to express an opinion as to what should be set apart until they knew exactly what was proposed on broad lines as a forest reserve; they desired also to have some say as to where the completed reservation lines should be placed.

The policy adopted by the Board of Forestry has therefore been to make a thorough examination of the locality in which a reserve is proposed, and suggest a comprehensive plan of what should be set apart as a forest reserve, irrespective of ownership or present availability for reservation.

This comprehensive plan is then submitted for consideration by both the public and the owners of private lands. These broad lines have been arrived at in each case after the fullest consultation with the government land commissioner, the local land owners and the local interests generally. So far no objection or opposition has been made to the reservation lines finally proposed by the Board, and the Governor has in every case adopted the lines recommended by the Board.

PRIVATE CO-OPERATION.

In connection with all the reserves so far made there has been the heartiest co-operation and manifestation of desire to co-operate with the Board of Forestry on the part of the owners of lands lying within the several reserves.

No private land owner has actually surrendered any land to the government as a part of a forest reserve, however, although in many cases they have voluntarily fenced out cattle from their lands and created practical forest reserves without such surrender.

The inducements held out to land owners to surrender lands to the government for forest reserves are first, exemption of such surrendered lands from taxes; second, the securing of government inspection to prevent injury to and interference with the forest; third, the securing of expert care, supervision and development of the forest; and fourth, the moral value of the example set in inducing others to give support to the forest reservation policy.

The newness of the proposition, together with the uncertainty as to what the future policy of the government will be in connection with the continuance of the forest reservation policy, has so far prevented the consummation of any surrender of private lands for forest purposes; but the proposition has been elaborated with great care between the Board of Forestry and the Alexander & Baldwin plantations on Maui, in connection with the forest lands of the latter in the Koolau and Hamakualoa Districts on the windward coast of Maui.

The plan proposed contemplates the surrender of the land to the Board of Forestry for a period of years, with a view to seeing how the proposition works out in practice. The owners reserve to themselves the right, subject to the rules and regulations of the Board of Forestry, to reforest the surrendered area and make such economic use of the forest products, both natural and those planted by themselves, as shall not be inconsistent with forestry purposes, and to resume possession and control of the surrendered land if the government withdraws its land from the reserve.

This proposition is now before the several Boards of Directors of the corporations interested, and agreements along the lines indicated will probably be concluded within a short time.

As soon as this sample arrangement is completed, copies thereof will be published and submitted to other land owners holding lands within forest reserves, with a view to extending the policy on the same general lines.

ECONOMIC USE OF FOREST RESERVES.

In this connection it should be brought home, more particularly to owners of land within forest reserves, that a "forest reserve" does not necessarily mean the locking up of a reservation and its abandonment to jungle growth.

In some cases, for example on the mountain section between Hamakua and Kohala, there is no probable use that can be made of the reservation except for water conservation. Under such circumstances the best use to be made of the reservation is to secure the greatest growth possible of vegetation and all that should be done is to assist nature by reforesting the open portions of the reservation.

In many other localities, however, for example in portions of the Hanalei, the Maui and the Hilo reserves, and in others now under contemplation, there can be, without detriment to the main object of maintaining the forest, economic use made of many of the now standing trees as well as by planting trees which can hereafter be made economic use of. In the earlier stages of the forestry program the main effort is directed towards establishing reserves, and later more effort will be directed to reforesting and making economic use of forest products.

REFORESTING AND PLANTING.

Owing to the financial condition of the Territory, the last Legislature did not feel able to make any appropriation for a general reforesting and planting program. The Bureau has not therefore been able to take up this work on any large scale.

It is, however, working on two lines in this connection: first, the collection of seeds of valuable trees which are disposed of at the cost price of collection. Large quantities of seeds of the more valuable trees in Hawaii, including the Acacias, the Eucalyptus and the Iron woods, have been made. This is important work, as a large proportion of the imported seeds do not germinate. The prices charged for the seeds are small—much cheaper than they can be imported for.

The second branch of this work being carried on by the

Bureau, is the giving of advice and instruction as to the best trees to be planted in particular localities and how to propagate, transplant and care for them. This service has been appreciated, and a constantly growing call upon the Bureau in this connection has been noted. The Bureau would be glad to have more use made of it in this respect. On request a representative of the Bureau will go to any portion of the Islands, lay out a nursery and give instructions as to how to care for the same, the expenses of course being borne by the persons for whom the work is being done. No charge is made for the services of the instructor.

AMENDMENTS TO FORESTRY LAW.

Two amendments to the forestry law were made by the last Legislature.

One was to render the law setting apart reserves more flexible than was the previous law. Under the law as it existed, it required an act of the legislature to remove any land from a reserve once it had been reserved.

Under the amended law the Governor may, with the approval of the Land Commissioner, after a meeting at which all interested have opportunity to be heard, take out specific portions of the reserve for specific purposes.

Although this amendment gives power to take lands out of a reservation which perhaps should not be so taken out, it is believed that the requirement of a public hearing and the growing understanding of the value of forest reserves will prevent undue exercise of the power, while at the same time it removes the fears of some that land suitable and proper for homesteading will be locked up in forest reserves.

The other amendment to the forest law of the Territory is Act 71 of the Laws of 1905, providing for the protection of forests from fire. This act specifically makes the willful, malicious and negligent setting of fire on any land not owned or controlled by the person setting fire thereto, and the wilful, malicious and negligent allowance of escaping of fire from the land of the person who sets it, on to the lands of another whereby any property of another is injured, a misdemeanor.

The act also provides for the appointment of district fire wardens in each district of the Territory, who have power and authority to act in case of fire in their several districts. Fire wardens have been appointed from among the most responsible residents of the several districts.

ECONOMIC FORESTRY.

Among the developments of the past year, looking toward the creation of economic value from forest sources, is the probability that rubber will prove a profitable crop in this Territory. The Hawaiian Department of Agriculture imported a number of rubber seeds some six years ago which were distributed throughout the Territory. In many places these seeds have grown and the trees are well developed and producing even now a good article of commercial rubber; and several thousand trees have already been set out and are doing well in the Nahiku District on the windward slope of East Maui. There is every reason to believe that the business of planting rubber trees will be engaged in on an extensive scale in a number of different localities in the Territory at an early date. For forestry purposes rubber trees are as good as any other variety, while they possess the additional value of producing an incidental profit.

THE BLACK WATTLE.

The other tree of economic value which I wish to call attention to, is the Acacia decurrens or Black Wattle, a tree which is common in many districts throughout the Territory.

In connection with the Tantalus forest there were planted some twelve or thirteen years ago a lot of six acres of this tree. The location was a rocky one with poor and shallow soil. The grove was included in the portion of the area set apart for the Federal Experiment Station. As the trees were not in a healthy condition Mr. Jared Smith, the superintendent of the Experiment Station, caused them to be cut this last spring, the bark removed and sold for tanning material and the wood sold. Careful statistics were kept by him of the results obtained from this small area. By his kindness I am able to present such results to this Association, which are as follows:

The six acres yielded 500 first-class fence posts which were used as samples and given to tanneries.

Thirty-six tons were sold at $23.31 per ton realizing a total amount of $839.44.

The six acres yielded 500 first-class fence posts which were used upon the station. These posts, if purchased, would have cost 25 cents a piece, making the value received from posts $125.

In addition to the fence posts there was realized 88 cords of fire-wood which was sold at an average of $7.83 per cord, producing a total of $689.25.

Allowing the same price for the two tons of bark given away there would be an additional value of $46.62.

A summary of the amount produced by these six acres of Black Wattle is then as follows:

36 tons of bark sold........................	$ 839.44
2 tons of bark given away.................	46.62
500 posts	125.00
88 cords of wood.........................	689.25
Making a total of........................	$1,700.31

or equivalent to $283.38 per acre.

As stated above the soil on which this grove was planted was rocky, thin and poor and the trees scrubby.

To my personal knowledge, in good soil on Tantalus and a number of locations on Hawaii and Maui, this tree grows to twice the size of the trees cut on Tantalus in much less time.

I am also informed by Mr. Smith that the Black Wattle bark is one of the best of the tanning barks, and the average price of good bark is much higher than that realized by him, the low price being on account of this being an experiment, its individual character being not yet established.

I am also informed by Mr. Smith that the demand for tanning bark is practically unlimited.

The foregoing demonstration by Mr. Smith opens up an entirely new field for a profitable industry in Hawaii, either as a proposition by itself or more particularly as an incidental profit in connection with plantations which are now having to purchase their fire-wood.

The tree is a quick grower, and planted along the lines of roads and in barren spots should furnish all the fire-wood needed by the plantation, leaving the bark a net profit.

ARBOR DAY.

The establishment of an annual Arbor Day in Hawaii stands to the credit of the year 1905. Although probably a majority of the trees planted out on that day will die, largely through ignorance of the proper method of caring for and transplanting the trees, the importance of this advance cannot be overestimated, as it will be the means of interesting a vast number of people in tree propagating and growth and their education in connection with such matters, who otherwise would never have had their minds turned in that direction.

ADDITIONAL FOREST RESERVES.

Mr. Ralph S. Hosmer, the Territorial Forester, has now well under way studies and reports upon forest reserves in Kohala, Kau and North Kona, Hawaii; the Ewa-Waianae basin and Waialua, in Oahu, and Kapaa and Kilauea on the island of Kauai, all of which it is hoped will be in condition to be acted upon and definitely set apart as forest reserves at an early date.

DESIRABLE AMENDMENT TO LAW.

As noted above the existing law does not permit the Governor to set apart as a forest reserve any government land on which there is more than a two years' lease.

This provision has not worked well. The theory upon which it was put in the law in the first instance was, that as the reservation could not go into effect until after the lease had expired it would make little difference whether the reservation were made now or at some time in the future when the lease had expired. It was also thought that it was preferable to set apart land for forest reservation only when the land was available for such purpose and not at a period prior thereto.

In practice it has been found, however, that the ability to now locate a forest reserve has considerable to do with the action of private owners in connection with their lands desired to be included in the reserve.

If government land which manifestly ought to be in a forest reserve can be now formally included therein, such inclusion to become effectual at the expiration of the lease, adjacent private owners know definitely what to calculate upon, whereas, if a part only of such government land is set apart and the remaining part is left in uncertainty to be dealt with in the future, the conditions are entirely different. The private owners interested and all concerned being left in uncertainty as to what will finally be included in the proposed reserve.

The plans for forest reserves should be as homogeneous and on as definite lines as possible. Uncertainty as to what is to constitute a reserve is as injurious to the main object as is uncertainty in any other proposition.

It is the opinion of all interested in the subject, to whose attention the matter has been brought, that the law should be so amended as to allow the Governor under the ordinary procedure, to set apart any government land for forest reservation purposes whether the same is now under lease or not, the reservation to take effect upon the expiration of the lease, unless other arrangements can be made with the lessee, which can frequently be done.

There are appended hereto copies of communications from J. M. Lidgate and D. Forbes, other members of the Committee on Forestry.

L. A. THURSTON,

Chairman, Committee on Forestry.

REPORT OF J. M. LYDGATE.

Lihue, Kauai, Oct. 3, 1905.

Mr. L. A. Thurston,

Chairman, Committee on Forestry.

There seems little to report concerning forestry on Kauai that is not already contained in the report of R. S. Hosmer, Supt. of Forestry. All that I know of since that report, is the completion of the McBryde forest fence and the fact that Koloa plantation is now engaged in setting out some 10,000 trees.

I think a good many places employ two or three men regularly planting and taking care of trees, and everywhere one sees signs of interest in this way.

The trees mostly planted so far as I have seen are Ironwood, Grevillia, Eucalyptus, Koa and Japanese plum. The latter tree in places is spreading naturally. On the lee side of the island Algaroba and Inga are valuable trees, easily grown and spreading naturally.

The ravages of cattle are being reduced to a minimum on this island—partly because the forest lands are being fenced off and partly because the lantana has choked up the trails and open glades. Goats and hogs exist in the mountain regions, but do not seem to injure the forest seriously, at least in the wet regions.

Respectfully yours,

J. M. LYDGATE.

REPORT OF D. FORBES.

Kukuihaele, Hamakua, Hawaii, Nov. 14th, 1905.

L. A. Thurston, Esq.,

Chairman of Committee on Forestry,

Honolulu, T. H.

As a member of your Committee on Forestry I beg to submit a brief review on some of the work done in aid of forestry throughout these Islands during the past year.

Through the spirited efforts of your Forest Commission and their able assistants, backed up by an interested Executive, more has been accomplished towards the reclamation of native forests than in any like period of the writer's experience on these Islands. A number of reserves have been created in various districts throughout the group, and although there remains much to be done in this line, a start has been made, which let us hope may lead to the formation of sufficient forest areas to meet the necessities of all agricultural pursuits.

The introduction of a "Real Arbor Day" has undoubtedly struck a most vital point in the future preservation and increase of our island forests for although the impression may not be left on the minds of all children who have planted a tree on that day, undoubtedly will leave with many a subject of interest and thought, who, in the future, will stand up and champion the protection and preservation of the reserves we now endeavor to create for them.

The Rubber Industry which, although, in its infant stage on these Islands, is evidently here to stay, will, let us hope, prove a success; adding in no small measure to the area of Exotic trees constantly being introduced with, attached to it that never failing impetus for continued planting, the inducement and hopes of a few stray per cent. as a reward for the energy and effort bestowed. So far as the benefits of forest go in ameliorating our island climate, it is of little moment whether it be a pine or a rubber tree, and if there is more revenue derived from the latter, let it be planted. Undoubtedly the tree giving off its usefulness to man without its final destruction must be the best tree to plant. This industry we will anxiously watch and earnestly wish that it may eventually reward the efforts and enterprise of those interested in its welfare.

Since considering the work of past years in the furtherance of forest timber production, it seems to the writer that there is much left for us to do in the preservation of the timber now being used or that intended for use in the future. I have no data at hand to demonstrate the measurement of timber yearly consumed by our island planters but conclude it reaches several millions of feet. Now let us assume such lumber to cost $30 per 1,000 feet and is intended for use in erection of flume, bridging, or R. R. ties, etc., and that the life of this timber under normal conditions is from 4 to 8 years and that for the half of its original cost the life of this timber can be doubled: will not all of us want to know how? This process of timber preservation is now long past the experimental stage in Europe, where as here lumber is expensive; each of the leading R. R. companies have their own "Creosoting" plants in which R. R. ties, telegraph poles, fence posts and pickets undergo treatment; while even now in the United States where lumber is much more plentiful the process is meeting with favor.

To install such a plant for timber treatment is expensive and I doubt if any single plantation would care to take it up, although several might jointly do so with economy.

A brief description of the plant now in the writer's mind may be of interest and is as follows: A long cylinder-shaped boiler eight feet in diameter with a swing door at either end similar to our Deming juice heaters; in this cylinder is stored the lumber for treatment. The swing door is then closed absolutely tight to resist a high pressure. From an adjoining supply tank boiling hot creosote is pumped into this cylinder until it has reached the innermost cells of all the timber being treated. This is ascertained by time and pressure and the quantity of material being treated. In the machine referred to, which held 6,000 sup. feet of timber, two charges were a day's work and always complete within ten hours. So soon as the curing is complete the creosote in machine not absorbed by timber is drained off and ready for use in succeeding charges. In tests made in the writer's presence of 10"x12" Scotch Fir R. R. ties, a timber similar to our N. W., after treatment the tie was cut through the center longitudinally and found to be thoroughly saturated to its innermost cells. As an example of its preserving qualities the common Scotch Fir used for R. R. ties was found, after five years under heavy traffic, to be no longer safe; with treatment its life was prolonged to ten years, thus in a great measure supplanting the Larch so much in demand for this purpose. The Larch no doubt would also, with similar treatment, be made to last proportionally longer if so desired, although the writer has no knowledge of its results with such treatment. The introduction of such a plant is not likely to be pushed by our local timber merchants, although I have every confidence it will well repay the cost to all consumers of timber for whatever purpose its use may be desired. I remain,

Yours respectfully,

D. FORBES.

REPORT OF THE SUPERINTENDENT OF FORESTRY.

Mr. President and Members of the Hawaiian Sugar Planters' Association.

The report of your Committee on Forestry has outlined the essential facts in the history of forestry in this Territory during the past year, but there are certain points to which I wish to call the especial attention of the members of this Association.

It is not necessary today to describe the organization of the forestry work under the Territorial Board of Agriculture and Forestry, nor to enter into a dissertation upon the desirability of protecting the forests on these Islands. The necessity of forest reservations on the important watersheds throughout the Territory is perhaps more apparent to you than to any other body of men in these Islands, and forest measures have always had the hearty support of this Association. There are, however, some features of the forest policy of this Territory that are not as well understood as could be wished,—of these I wish to speak.

The work of the Division of Forestry for the past year has followed closely the program adopted when the Division was organized, not quite two years ago. The creation of forest reserves has held first place and has occupied the greater part of my own time as Superintendent. During the year five reserves have been set apart in the Territory; two on Hawaii, one each on Kauai, Oahu and Maui. The five reserves have a combined total area of 210,322 acres, of which 56,757 acres of government land have been actually set apart by proclamation by the Governor.

Following is a list of the reserves, with data as to their creation, area, date of proclamation, etc.

FOREST RESERVES.

No.	Name	District	Island	Area Government Land Actually Reserved	Total Area Recommended to be reserved	Date of Proclamation	Proclamations Signed by
				Acres	Acres		
1	Kaipapau	Koolauloa.....	Oahu ...	913	913	Nov. 10, 1904	Geo. R. Carter
2	Hamakua-Pali.	Hamakua ...	Hawaii..	17,000	18,940	Dec. 23, 1904.	Geo. R. Carter
3	Hilo	Hilo..........	Hawaii .	12,771	110,000	July 24, 1905	A. L. C. Atkinson
4	Koolau-Maui..	Koolau, Hamakua-loa.....	Maui ...	15,083	42,969	Aug. 24, 1905	A. L. C. Atkinson
5	Halelea	Halelea	Kauai...	10,990	37,500	Aug. 24, 1905	A. L. C. Atkinson
				56,757	210,322		

The procedure of making forest reserves in Hawaii and the relation between the total area within the reserve boundaries and the area actually set apart may be thus described.

Following an examination on the ground, the Superintendent of Forestry recommends to the Board of Commissioners of Agriculture and Forestry the reservation of the area, which in his judgment should, for the best interests of all concerned, be kept permanently in forest. If the Board approves this report it adopts a resolution favoring the reserve. A public hearing is then held by the Governor and the Board for an expression of opinion. If no opposition develops, the Governor by proclamation recommends the reservation of the area suggested by the Superintendent of Forestry and actually sets apart such government lands within the boundaries of the reserve as are not under lease, or on which the leases are within two years of expiration. Thereafter the other government lands within the reserve are set apart as their leases expire. The individuals and corporations owning or controling land within the reserve are asked to cooperate with the Board, under the law, that by the adoption of an organic system of forest management, the objects for which the reserve is created may be attained. Except as the owners cooperate with it, the Board can exercise no jurisdiction over the private lands within the reserve.

The general attitude of the present administration on the forest policy of the Territory was summed up in a correspondence between Governor Carter and myself, which was made a part of the report submitted by your Committee on Forestry last year. Since that time several points in the policy have been more clearly defined in consequence of questions which have come up relative to the creation of one or another of the reserves.

As perhaps the most important change, there should be mentioned in this connection the amendment of Act 44 of the Session Laws of 1903, (Chapter 28 of the Revised Laws), by Act 65 of the Session Laws of 1905, whereby the Governor may, "with the approval of the Commissioner of Public Lands, after a hearing * * * * * revoke, modify or suspend any and all the orders and proclamations or any part thereof, which set apart" forest reserves.

This act, passed at the instance of the Land Commissioner, is designed to provide a less cumbersome procedure than existed under the old law, for the withdrawal of land within the limits of forest reserves, which changed economic conditions may make available for development. On the whole I approve of this amendment, although I believe that it would have been better had the approval of the Board of Commissioners of Agriculture and Forestry, as well as of the Commissioner of the Public Lands, been required.

This brings up the matter of the location of the boundary lines of the forest reserves, with reference to possible agricultural land. It is the settled policy of the Board of Agriculture and Forestry to fix the boundaries so that all land likely to be needed for agricultural development shall be excluded. In the location of the reserve boundary lines the possibility of the agricultural development of the section is always taken into account and the line wherever possible, is so laid out that it may be a permanent one.

There are, however, one or two districts where with better transportation facilities, successful agricultural development could be pushed further than is feasible under existing conditions, but where, until the success of such development can be assured, the land serves a better purpose by being kept under a forest cover. In such localities it is sometimes advisable to draw a forest line that may later be modified. But in most cases the attempt is made to so draw the line now that the reserve include land which is suitable only for forest. By so doing there is little occasion for the new law to be invoked, but being on the books it prevents opposition to proposed reserves which might otherwise develop.

Perhaps next in importance to the creation of the reserves is the question of securing the co-operation of the corporations and individuals owning land within the reserve boundaries. As was explained above, the Governor and the Board in declaring the boundaries of a given reserve go on record as recommending that for the best interests of the Territory as a whole, the given area be permanently reserved as forest. The administration then shows its good faith by actually setting apart the government lands not then under lease and, subsequently, the other government lands as the leases on them expire. In some reserves the major part of the area within the boundaries is government land, in others the proportion of private holdings is as great as that of the government lands.

That the reserve as a whole may be administered to the best advantage, it is essential that a systematic and organic plan be adopted and carried into effect. This cannot be done if a number of diverse, perhaps conflicting, interests have each a voice in the management. For this reason the Board of Agriculture and Forestry requests the private owners to entrust to it the management of their lands, under the provisions of the law creating the Board. The exact form of agreement to be entered into by the individual and the Board, whereby this end can be accomplished, is one of the problems on which the Board is still working. It will doubtless be found that like all reserve work, each case must be decided on its own merits and with special reference to individual conditions, but these are details which will work themselves out, in due course.

The main object of the Board at present is to secure the interest and co-operation of the private owner, for without unity of purpose and harmony of action, the reserves cannot be made of the most use to the Territory. Very unfortunately the lack of available money in the treasury entails a particular hardship on this branch of the work. Money for the pay of forest rangers was cut out of the last appropriation bill altogether, leaving the Division of Forestry at present in the anamalous condition of having forest reserves, but no force with which to administer them. This lack of men to carry a definite policy of forest reserve administration into effect has and will deter the private owner from turning over to the Board the management of his forest land. In several instances an arrangement has been made through the employment of what are practically volunteer rangers, which will serve for the present, and I think give good results. But this can only be regarded as a temporary expedient. The condition is one which must be remedied or our reserve system will never be efficient.

It is to this end that I particularly desire to obtain the assistance of this Association, for if the Board of Agriculture and Forestry can go before the next Legislature with a definite proposition of a series of forest reserves, in part composed of private lands, on which the owners will co-operate with the Board, provided a system of forest administration is put into effect, there is good reason to expect that the necessary money for the employment of forest rangers can be obtained.

I am confident that once the conditions are understood the money will be forthcoming. Consequently the creation of new reserves is being steadily pushed. Next year I expect to report the addition of large areas to the present list of reserves.

There is necessarily much preliminary work which must be done in the field and in the office before a given forest reserve can be set apart. At the present time many projects are under way in various stages of completion. In the comparatively near future it is expected that forest reserves will be created in Kau, Hawaii, in the Ewa and Waialua Basins on Oahu, on the Kohala Mountain on Hawaii, and in the District of Puna on Kauai. Plans are also well in hand for the creation of reserves on the West Maui Mountain, on the Waianae Hills on Oahu, and on Lanai, while the examination of lands on the leeward side of Kauai and on Molokai, will be undertaken as soon as may be.

While on the question of forest reserves there is one other point which should be mentioned—that is the attitude of the Board of Agriculture and Forestry regarding the great stretches of waste land on the higher mountains of the Territory. It is the policy of the Board to recommend that the portion of a land above the area of profitable grazing country be retained by the Land Office when the valuable portion of the land is again leased, instead of as now being thrown in as a sort of "manuwahi." Much of the upper land could be made to grow valuable forest trees. It may be that sometime in the future this work can be undertaken. Therefore it is well that the land remain in the hands of the government rather than that it be granted to private persons for a long term. A case in point, when this policy was carried into effect, was the land of Kaohe 4, on Hawaii.

So far as possible the Division of Forestry is carrying on other lines of forest work, although the limited appropriations at the disposal of the Division greatly retards many things which we should like to do.

The giving of advice and assistance to individuals or corporations desiring to do forest tree planting is perhaps the most important work of the Division of Forestry, next to the creation of forest reserves. Upon request, Mr. David Haughs, the Forest Nurseryman of the Division of Forestry, will visit and inspect the land which it is desired to plant, and give advice in regard to the kinds of trees best adapted for the locality, with suggestions as to the best methods to be followed to insure success. If a large area is to be planted it is recommended that local nurseries be started in which the seedlings to be used can be grown. When only a few hundred are needed they may be obtained at cost price from the Government Nursery in Honolulu, as may also the seed of the more important island and introduced trees.

A circular is about to be issued offering the advice and assistance of the Division in a more general way than has been done heretofore, which it is hoped will be followed by numerous applications. There is no charge for the advice given beyond the payment of traveling expenses of the agent sent.

Among the features of the past year's work worthy of special mention, is the forest fire law enacted at the last session of the Legislature. The act is carefully framed and will, it is believed, be of much benefit to the Territory. To call the attention of the people to the law and to awaken a sense of responsibility among those who set fires which might spread to the forest, fire warning notices have been printed on cloth and very generally posted throughout the Territory. District Fire Wardens have been apointed in the several districts on each island to carry out the provisions of the law. By these means it is hoped that much may be done to prevent fires in the future, the best way to combat this worst enemy of the forest.

It is of interest also to mention the successful celebration of the first Arbor Day to be officially observed in Hawaii. The day selected was November 3rd, and while essentially a day of school-ground planting, a good share of interest was aroused throughout the community which can but lead to good results.

Altogether the past year has been a favorable one and shows good progress. But the field for forestry in Hawaii is a large one and there is much which waits to be done.

If we are to make the most of the undoubted opportunities that exist here we shall continue to need the support of all who have at heart the welfare of the forests of these islands. That support assured, the outlook for the future is bright.

A vote of thanks was extended to Mr. Hosmer for this paper, which he had prepared on two days' notice.

RUBBER.

Mr. Hall—speaking on rubber—I am connected with the Nahiku Rubber Company and have had a good deal to do with the importing of the seeds and plants. We have already planted out in their permanent places about 26,500 plants of two varieties, about 11,200 of the Ceara rubber, 14,800 in Hevea, which is considered the finest rubber in the world. The plantation will eventually consist of about one-third of Ceara and perhaps two-thirds of the Hevea with a few of the Castilloa. We have 500 plants of this latter variety, which is the kind grown in Central America and Mexico. The most of the seeds of the Ceara were imported from Paris, but unfortunately they must have been from old stock, because although a hundred thousand seeds were imported, only about ten per cent. of them germinated. The Ceara seed has a very hard outer shell, and the edges of the seed have to be filed in order that the moisture may penetrate and start the germination. The Hevea seeds are about as large as the small walnut. We only received those about three weeks ago. They came from Ceylon. We received about 5,000 seeds from Singapore, which is about sixteen hundred miles this side of Ceylon nearer to the Islands and we will, therefore, try to obtain most of our seeds and plants from Singapore. We are in communication now with parties there who are very much interested in the venture and through them we can import our seeds, etc. The Hevea only retain their vitality for two or three months after they are taken from the tree, and it takes two months from the time they start before we obtain them. They arrived here on the steamer, and with about 1800 tons of freight, were thrown on the wharf and mixed up with Chinese and Japanese packages of all kinds, so that they could not be sent to Maui the first week. They were taken over to Maui the next week. Five Wardian cases were started from Ceylon with damp saw-dust in the bottom. In this sawdust were planted about 1,000 seeds in each case, but before they arrived here the seeds had germinated and grown to the top of the cases, some of them perhaps two feet high, but the cases were completely filled so that when the glass covers were taken off, the leaves would spring out by themselves. They were sent to Maui and planted out. Besides the 26,500 plants now growing, we have 33,000 Hevea seeds planted, which are now germinating very rapidly. We are expecting 60,000 more stumps or plants by any China steamer that may come in now. The order was for 75,000; 15,000 of these are for the Koolau Rubber Company. By next January we hope to have about 100,000 plants growing.

Mr. Campbell—How far apart have you planted those seeds?

Mr. Hall—The trees are planted about ten feet apart or even closer, as the Hevea grows to be a larger tree than the others. We set them out perhaps 10 feet apart one way and then 15 feet the other way, that is 10 feet this way and then another row fifteen feet from that, giving the tree a chance to develop in the sides, making sort of open rows.

The Chairman—Isn't that the kind of rubber tree that takes such a long while to develop?

Mr. Hall—The Ceara is the kind that requires such a long time. Any of these trees can be tapped as soon as they get circumference enough or diameter in the stem, but they should not be tapped, perhaps, for three years, I should think. I am not an expert, though, on rubber; but as to what we have actually done, I can tell you all about that. Mr. Anderson, who has been in Mexico and Central America, is the manager of this plantation; there is another plantation started at Koolau, the Koolau Rubber Company, and there are several private individuals who are planting rubber.

The growth of the Cerea is something phenomenal. We have plants there that are from twelve to fifteen feet high, the seeds of which were planted out last February, and they have seed pods on them already. I brought a leaf down with me when I came down the last time, which is in the window at Hall & Son's, and as you go by there you can look at it. It shows the growth of the tree, that is all. Of course there is nothing in a leaf, but it shows what an immense growth these trees make. There are also some samples of rubber in the window that were taken from these trees, so that it is really no experiment with this Ceara variety. It has been pronounced by experts to be one of the best rubber trees existing, and there are also some samples taken from trees down at Nahiku. The trees grew to be forty or fifty feet high.

Mr. Goodale—What is the elevation?

Mr. Hall—Possibly 500 feet.

Mr. Goodale—What elevation are you planting at?

Mr. Hall—Our highest land is about 1,500 feet. There is only one piece of land that runs up as high as that.

Mr. Goodale—What is the lowest?

Mr. Hall—The lowest is about three hundred feet; but our lands average from about eight hundred or a thousand feet to eighteen hundred feet. Mr. Baldwin would know about that. He has been up there.

The Chairman—I have not been on the plantation, but I have been at the other end and I expect it is higher than a thousand feet.

Mr. Hall—Yes, they run up pretty high.

Mr. Goodale—Is that considered the proper range?

Mr. Hall—We are planting our Ceara variety on the higher elevations, because it grows better at a higher elevation.

Mr. Goodale—What is the rainfall?

Mr. Hall—I have the rainfall for five years. The lowest was about 125 inches in a year and I notice the highest is about 278.

Mr. Smith—I would like to ask Mr. Thurston in regard to the Black Wattle. How is it propagated?

Mr. Thurston—It is very easily grown from seed. It is the ordinary Acacia, of which there are two or three kinds common on the Islands, the Silver Wattle and the Black Wattle so-called are the commonest. I do not know why it is called Black, because it is a bright green instead of being silvery or black.

Mr. Smith—It is a tree that is suitable for planting along the roads and highways?

Mr. Thurston—Yes. It is an Australian tree brought here first by Captain Makee. As a rule, it is not a long-lived tree. It is fit for timber, posts and firewood.

The Chairman—Does it make good fence posts, good substantial posts to keep in the ground?

Mr. Thurston—I am not positive of how long it will last, but I believe that it does. It is a tree which they have had at the Haleakala Ranch in considerable numbers, many of which have been dying out recently apparently on account of a bark borer, although Forester Hall was not sure whether the borer was responsible for its death or whether the tree had just run the length of its life and died naturally.

In regard to rubber I would say that about a dozen of the Ceara variety were planted at Olaa about a year or so ago, which are now from fifteen to twenty feet high, and are growing luxuriantly.

Mr. Hall—As to the ficus elastica, I would say that that is a tree that is used all over the world. It is a beautiful tree. You have seen them here in town. The tree doesn't produce a great stock of gum, so it really doesn't pay to raise them.

The Chairman—I am not a rubber expert, far from it, but I have seen, although not the rubber trees that Mr. Hall speaks of, other trees at Nahiku and different places. We are constructing a ditch near the rubber plantation on Maui and I would like to say that you must not run away with the idea that you can raise rubber anywhere, because, as I understand from my talks with Mr. Anderson and other persons it will not grow well in a windy country. The conditions at Nahiku seem to be favorable, although probably it rains a little too much during a part of the year, but the soil is very largely composed of "aa," which is a rich rock which contains a good deal of plant food, as we have found by analysis, and decomposes readily.

Mr. Forbes—In regard to the rubber tree, ficus elastica, that is the tree that supplies the product called Assam rubber, the one grown on Hawaii. It has been growing, I know, on Hawaii for the last twenty years. We have had one plant growing there now for seven years, I believe, having been introduced by Mr.

Morrison when he was in the Government employ, and if the tree grows well, I think it would be wise for all the rubber plantation managers to grow it.

I have been reading an article lately in the Tropical Agriculturist written by the Editor, who gives the experience of Ceylon planters and others in regard to the Ceara who have grown the tree six or seven years in large numbers, and they came to the conclusion that it would pay to cut out the Ceara and plant the Hevea variety. Now, if that has been the experience of those planters, I think that due inquiry should be made before large areas of this Ceara rubber are planted. Though it does grow well, I understand that the quantity of rubber produced isn't sufficient to make it a paying enterprise.

Mr. Hosmer—In regard to one point that has been mentioned, I would say that rubber requires a great deal of heat to come to its best condition. Heat and water seem to be the two requirements. At Nahiku the conditions seem to be extremely favorable. I trust they will prove to be so elsewhere, but I think before planting is done on a large scale, that there should be experimental work first.

Mr. Moir—speaking of the Greville tree—Is it good for fence-posts or can it be made into lumber suitable for plantation use? It is a tree that grows very fast. I know that I planted one or two trees there at Honomu about eight or nine years ago, and I believe that some grew as high as forty feet, with a trunk possibly fifteen or eighteen inches in diameter, say up to eight feet from the ground.

Mr. Forbes—I have had some experience with the tree. It is a very fast growing tree and I think one of the best trees suited for all around work. It is a hard-wood tree but is not the thing for plantation purposes. Its use is more as a hard wood for furniture or carriage building or something like that. It does not compare with any other of the hard-wood trees in texture, such as ash, oak or any of those timbers. It is a very pretty tree and would be good for ornamental purposes.

Mr. Thurston—Does it make good fence-posts?

Mr. Forbes—No, because it does not last long enough.

Mr. Thurston—I was in Hamakua, recently at Mr. Louisson's coffee plantation. He has been experimenting with many of the varieties of trees to produce shade for the coffee plants. He told me that he was now using, almost exclusively, the Greville trees. They grew very rapidly, and produced just about the right amount of shade for the plants, and their leaves fell down and spread over the grounds and so kept the weeds from growing.

Mr. Forbes—In Ceylon they are using the Greville trees almost entirely for shade trees to cover the tea-plants.

The Chairman—We planted out a great many on Maui.

Mr. Hosmer—One trouble is that we have planted a great many trees in the past but they have not come to a stage where they have been large enough to cut and utilize, so that we have not very much basis for stating their usefulness, and will require more experience to speak further. I hope in a short time to compile all of the data which can be secured.

Mr. J. Kotinsky—While it is not connected with forestry or rubber, I thought it might be apropos to suggest to the planters of rubber to be careful about their importations. The importations of any plants from the East or Australia, Asia, Ceylon or India, will be looked after by our most vigilant inspector, Mr. Craw; but if, as there is a rumor, plants come from either California or perhaps (as in the case of rubber) Central and South America along the coast and then by steamers running direct to Hilo and Kahului without touching at Honolulu, there is some danger that these will bring along with them pests that would prove of danger to practically everything we have growing on these Islands. A few weeks ago, it fell to our lot to discover that, some three years ago, some lemon trees were introduced from Fiji, upon which at that time were probably a few specimens of a scale insect which has increased since then. This scale is known to have put the finishing touches to coffee in Ceylon and is reported as having been found in Ceylon and India upon rubber plants, guava and many other plants that are cultivated. At that time, so far as I know, there was no inspection, certainly no inspection as we understand it since Mr. Craw came to these Islands. It is fortunate, I say, that we have made the discovery in time, and that the insects that came over were very few; that being immediately seized upon by parasites that were already introduced here by Mr. Koebele, they didn't spread very far. We hope now that by the burning of these few trees (only three of them), we have destroyed the pests on these Islands. It is an easy matter to evade the most vigilant inspector if any one desires to do so, but it cannot be urged too strongly upon all the inhabitants of this Territory for their own good and for the good of their neighbors, to say nothing of the welfare of the entire Territory, to insist that no matter where the plants come from, that they don't get into their possession, before they have passed through the hands of the inspector. Several such discoveries have been made within the past few months and to the casual observer it would appear as though those introductions were made within the past few months, but as a matter of fact it is not so, but those introductions were made three to ten years ago, though they were not discovered until now. Since they have been observed, everything has been done to check their spread and to exterminate them if possible. I will therefore repeat that every importer of plants or anything pertaining to plants should be his own officer and self-constituted inspector to see that nothing passes without the examination of a competent inspector for both insects and fungus diseases. If I am allowed, I want to add a few remarks concerning the lantana insects. Now and then reports come in from various districts of the Territory saying that the Lantana bug, as it is known collectively, is doing injury to this and that group of plants. To my knowledge there are five of those insects. The most numerous of them all, so far as I could see, are the Lantana seed-fly, the leaf miner, which produces big spots upon the leaves, and finally what we know as the Tingid Lantana leaf bug. Of the five, the Lantana leaf-bug is the only sucking insect. The others actually devour their food, as if they had teeth. Perhaps none of these five insects occur in as large numbers as does the Lantana seed-fly, yet even a competent observer seldom gets the opportunity to see the fly in the field. The only way we can see the fly and observe it in operation at all, is to collect a lot of the insects and breed them in the laboratory. Certainly the Tingid has increased in enormous numbers within the past year, as it seems. It is a slow walker, so that even a layman could spend a considerable number of seconds in observation of them and while he would know very few insects, unless those of the sugar cane and others equally notorious, he knows this insect about as well as he knows any other on the Islands, for the reason that it is, as I said, a slow-moving insect, and does not fly very readily. It is perfectly natural, that the bug would be carried to every other plant in the vicinity. There it is observed, and immediately suspicion falls upon it as being the insect, that does all the damage, which is probably attributable to a thousand and one other insects. With this knowledge in view, it will perhaps quiet the minds of those, who are apprehensive as to the future of vegetation on these Islands. One prominent grower in Kona recently went so far as to say that all vegetation in that district was doomed and that it was all due to the Lantana bug, which was the only one that he knew of, until he was informed to the contrary, which I did as soon as I saw him.

Mr. Moir—I have observed within the last three months a new sort of a caterpillar. It is of a light green with a dark stripe running lengthways of the caterpillar. It has got a little thorn, as it were, sticking out just over its head or a little horn. I have never seen it until within the last month or two.

Mr. Giffard—How large is it?

Mr. Moir—From half an inch to an inch.

Mr. Giffard—It would be of great assistance to the staff of the Experiment Station, if, when the managers see anything which they know nothing about, they would simply bottle it and send it down to the Station and then they will be sure to learn what it is.

There are scores of caterpillars and other pests which are difficult to identify without specimens, and the only way to be sure about any insect is for the entomologists to have a specimen of it for examination when it will not take five minutes for them to identify it. I am sure that the entomologists would be very glad to spend any amount of time in looking such matters up and giving you information about them.

Mr. Hosmer—There is one other thing about rubber which might be of interest to the members of this Association.

Some years ago Prof. Koebele brought back some Central American rubber, the Castilloa elastica, which was propagated in the nursery. We have now about twenty-four trees of that variety. Through an arrangement with Mr. S. M. Damon, I am propagating those trees in the valley above the polo field in Moanalua. When they are large enough so that cuttings can be taken or a sufficient number have been obtained, they will be distributed throughout the Territory.

Mr. Hall—We have about 2,500 of those Castilloa growing which are about a foot high.

Mr. W. H. C. Campbell—I would like to inquire whether there is any danger of introducing pests by the importation of seeds, plant seeds of any kind. I know that a great many seeds are coming direct to Hilo; in fact, some of the members of my own family have sent for seeds at different times and have received them direct. I am almost positive they were not inspected, as they arrived in the Hilo post office direct from the coast. I do not think that there is any inspection of that kind there. I do not know if there is any danger, but I thought there might be.

The Chairman—I have just ordered a large amount of flower and vegetable seeds from San Francisco. I know we have received seeds of various kinds in the past on Maui which have come direct and I do not think they were inspected.

Professor Perkins, the question has been raised as to whether there is danger of introducing pests by the importation of flower and vegetable seeds. What is your opinion about that? Do you think there is danger through importing seeds, that the pests might come along with the seeds?

Professor Perkins—I do not think there would be any danger in bringing in garden seeds that way. Of course you can not tell what is in the package until the person to whom it is addressed gets it out of the postoffice; every package that comes into the country is not always opened at the postoffice.

In regard to packages of plants and seeds, however, that come from Fiji and such places, I know that when I was doing the inspecting that the postoffice always notified us if they had any reason to anticipate that there were plants and seeds, and a careful examination was made.

Professor Perkins—I do not think there would be any danger in introducing pests with the ordinary garden seeds; but there might be in cases like rubber seeds and mango seeds.

Mr. Hall—All the packages of rubber seeds, we received for our plantation, were examined and fumigated by Mr. Craw; it took him two days to do it.

Mr. Giffard—I think Mr. Lewton-Brain might give us a few points on this matter of seeds. I know that Mr. Lewton-Brain has written on the subject in the West Indies. I have read some of his lectures on that subject, and it would be interesting to hear from him.

Mr. Lewton-Brain—In many cases, I think there is certainly danger of importing fungus spores with the seed, especially those fungus diseases which attack the seed-bearing organs—the fruits. Very often in that way fungus spores are carried from one country to another. I think the most classical instance of a fungus being distributed by the seed is that of the smut on wheat and oats. That fungus is entirely distributed by its spores attached to the grains of the cereals and in many other fungoid diseases of the fruit, there is certainly a very grave danger of fungoid diseases being introduced with the seed. As to whether or not the danger in any particular case is a great one, will have to be decided on the merits of that special case, taking into consideration whether or not that particular plant is known to be attacked by any fungus, which can be distributed in that way, as well as considering the country from which it is proposed to introduce such plant. There is not much danger of introducing leaf, stem or root diseases with the seed, but there is danger of introducing fruit diseases with the seed.

The Chairman—I suppose they have been introduced to some extent in that way; but if you subject them to a severe fumigation, of course they will not germinate.

Mr. Lewton-Brain—I do not think that hydrocyanic acid would kill all the fungus spores.

Mr. Forbes—I think that when you speak of flower seeds and things of that sort, you are killing the midget and swallowing the monster. What comes in with all of our barley which is passed without any examination at all? Is there not just as much danger of an insect being introduced into the country with our barley as there is of a package of flower seeds with insects coming through the mail?

Mr. Kotinsky—It has been my privilege on several occasions to do inspection work with Mr. Craw. Perhaps if we understand the procedure we will have a better idea of how mail matter is inspected. The postal authorities, especially the present Postmaster, at first refused to allow Mr. Craw to make inspections of any kind, because the postal regulations required that mail matter be delivered unopened. Special correspondence was had on the subject with the Postmaster General by the Board of Agriculture & Forestry and a permit was granted to the Inspector to examine packages. Now, any package bearing a description of its contents, if not overlooked by the mail distributor, is placed upon a separate table, which is visited by Mr. Craw after the arrival of each steamer, and all those packages are examined and those that require treatment are treated and ultimately all the packages are stamped with the inspector's stamp. Mr. Craw has a special stamp for that purpose. When a package is found that shows suspicious signs of insect or fungus work on the plants, those that are dead are chucked away (there is no use treating them, for they are of no use to the importer) ; while those that are alive, are treated and delivered.

Dr. Cobb—I have received from Australia since being here several letters containing seeds and native vegetation, and I presume that a great many other people have also received seeds and flowers in letters which are never inspected. Now, if every one could be made to realize what great damage might be done to the country through the careless importation of pests in this manner, I think it would do a great deal of good, and I trust that the reporters of this discussion will give it the widest possible circulation.

Mr. Moir—How about the plants?

Dr. Cobb—That would be a much more difficult matter. Plants that are sent in letters in a quite dry condition might easily carry the spores of the disease of those plants in a living condition, although the plants themselves were dead.

Mr. Giffard—The law is specific in regard to plants, Mr. Chairman. It states that no plants shall be imported into this Territory excepting through the Port of Honolulu. I believe the fine is somewhere between 100 and 500 dollars for each offence.

The Chairman—I think, Mr. Giffard, you ought to call the attention of the authorities to the fact, that plant are illegally introduced.

Mr. Giffard—It is a very serious matter on account of the losses by pests in this country costing us a great many millions of dollars, we might say, annually. It should be well considered.

Mr. Smith—I think that any one who imports plants surreptitiously without inspection should be subjected to the full penalty of the law.

Mr. Giffard—It is a criminal act. It is very easy for people living on the other islands when they want plants or shrubs to have them come through their agents in Honolulu and be carefully inspected and if necessary fumigated, which fumigation will not cost them a dollar and they will get them in perfectly good order, that is providing that they are of such a nature as to stand a journey.

The Chairman—We have officers here in the country who should see that the law is carried out. I plant out each year a good many trees, (orange trees and peach trees), that I import, some from Florida and some from San Francisco. They come generally on the steamer that lands at our port. They come through Honolulu and up to Maui. I do not know whether they are inspected; all I know is that they are delivered to me there in crates and boxes. I should say they should be examined here at this port, but I am not positive as I say, whether this has been done or not in the past.

Mr. Giffard—My attention has been called by Mr. Moir, Mr. Chairman, to the fact that a good deal of the mail for Hilo comes in closed bags through Honolulu and these bags are sent up to Hilo; they are locked and sent to Hilo through Honolulu without being opened here. Of course the postmaster has no authority to open locked bags destined for another port;, but it seems to me that the Board of Commissioners of Agriculture and Forestry should do something towards having an inspection made at Hilo and at Kahului, at the postoffices there. There are parties there who are qualified to do it and I am sure they would be only too glad to do it. There is an entomologist in Hilo, who is qualified in every way to make such inspections, and he would do it for a very small consideration whenever the postoffice would call upon him. The trouble is, however, that the postmasters take no interest in the matter; if anything comes along that will give them any trouble, they pay no attention to it.

The Chairman—Is the law explicit that plants should be examined in the out-ports?

Mr. Giffard—The law is explicit that no vegetable life, except fruits and vegetables for immediate use, shall be imported into the territory excepting through the Port of Honolulu.

The Chairman—I suggest, that such a committee be appointed to wait on the Governor and on the proper authorities and call their attention to the fact, that the law is being evaded and should be carried out, because it is a very serious matter to us all.

The Chair appointed a committee to wait upon the Governor and the other authorities and see that the law in regard to the importation of plants into this Territory be strictly enforced.

The session was then adjourned sine die.

Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POST OFFICE.
OAHU.			
Apokaa Sugar Co.	*	G. F. Renton	Ewa
Ewa Plantation Co.	*	G. F. Renton	Ewa
Waianae Co.	***	Fred Meyer	Waianae
Waialua Agricultural Co.	*	W. W. Goodale	Waialua
Kahuku Plantation Co.	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co.	**	G. Chalmers.	Waimanalo
Oahu Sugar Co.	x	E. K. Bull	Waipahu
Honolulu Plantation Co.	**	J. A. Low	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co.	**	Geo. Gibb	Lahaina
Pioneer Mill Co.	x	L. Barkhausen	Lahaina
Wailuku Sugar Co.	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sug. Co.	x*	H. P. Baldwin	Puunene
Maui Agricultural Co		H. A. Baldwin	Paia
Kipahulu Sugar Co.	x	A. Gross	Kipahulu
Kihei Plantation Co.	x*	James Scott	Kihei
HAWAII.			
Paauhau Sugar Plantation Co.	**	Jas. Gibb	Hamakua
Hamakua Mill Co.	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	J. M. Horner	Kukaiau
Kukaiau Mill Co.	*x	E. Madden	Paauilo
Ookala Sugar Co.	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co.	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	J. M. Ross	Hakalau
Honomu Sugar Co.	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co.	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co.	**x	J. T. Moir	Hilo
Hilo Sugar Co.	**	J. A. Scott	Hilo
Hawaii Mill Co.	x	W. H. Campbell	Hilo
Waiakea Mill Co.	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co.	**x	Wm. G. Ogg	Pahala
Hutchinson Sugar Plantation Co.	**	Carl Wolters	Naalehu
Union Mill Co.	*x	H. H. Renton	Kohala
Kohala Sugar Co.	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co.	x**	K. S. Gjerdrum	Honokaa
Olaa Sugar Co.	xx	J. Watt	Olaa
Puna Sugar Co.			Kapoho
Halawa Plantation	x*x	T. S. Kay	Kohala
Hawi Mill & Plantation	††	John Hind	Kohala
Puako Plantation	††	W. L. Vredenburg	S. Kohala
Niulii Sugar Mill and Plantation	*x	Robt. Hall	Kohala
Puakea Plantation	*x	H. R. Bryant	Kohala
KAUAI.			
Kilauea Sugar Plantation Co.	**	A. Moore	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co.	....	G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co.	x	F. Weber	Lihue
Koloa Sugar Co.	x	P. McLane	Koloa
McBryde Sugar Co.	*x	W. Stodart	Eleele
Hawaiian Sugar Co.	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co.	*	J. Fassoth	Waimea
Kekaha Sugar Co.	x	H. P. Faye	Kekaha

KEY.	HONOLULU AGENTS.	
*	Castle & Cooke	(5)
**	W. G. Irwin & Co.	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co.	(9)
*x	T. H. Davies & Co.	(8)
**x	C. Brewer & Co.	(6)
x*	Alexander & Baldwin	(6)
x**	F. A. Schaefer & Co.	(2)
x*x	H. Waterhouse Trust Co.	(2)
††	Hind, Rolph & Co.	(2)
xx	Bishop & Co	(1)